US009759098B1

(12) **United States Patent**
Chapman, Jr.

(10) **Patent No.: US 9,759,098 B1**
(45) **Date of Patent: Sep. 12, 2017**

(54) **VALVETRAIN CONVERSION KIT FOR AN ENGINE**

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(72) Inventor: **William Cullen Chapman, Jr.**, Torrance, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/261,667**

(22) Filed: **Sep. 9, 2016**

(51) **Int. Cl.**

F01L 1/02	(2006.01)
F01L 1/053	(2006.01)
F01M 9/10	(2006.01)
F02B 67/04	(2006.01)

(52) **U.S. Cl.**
CPC ***F01L 1/026*** (2013.01); ***F01L 1/053*** (2013.01); ***F01M 9/105*** (2013.01); ***F01M 9/106*** (2013.01); ***F02B 67/04*** (2013.01); *F01L 2250/06* (2013.01)

(58) **Field of Classification Search**
CPC F01L 1/026; F01L 1/053; F01L 2250/06; F01M 9/105; F01M 9/106; F02B 67/04
See application file for complete search history.

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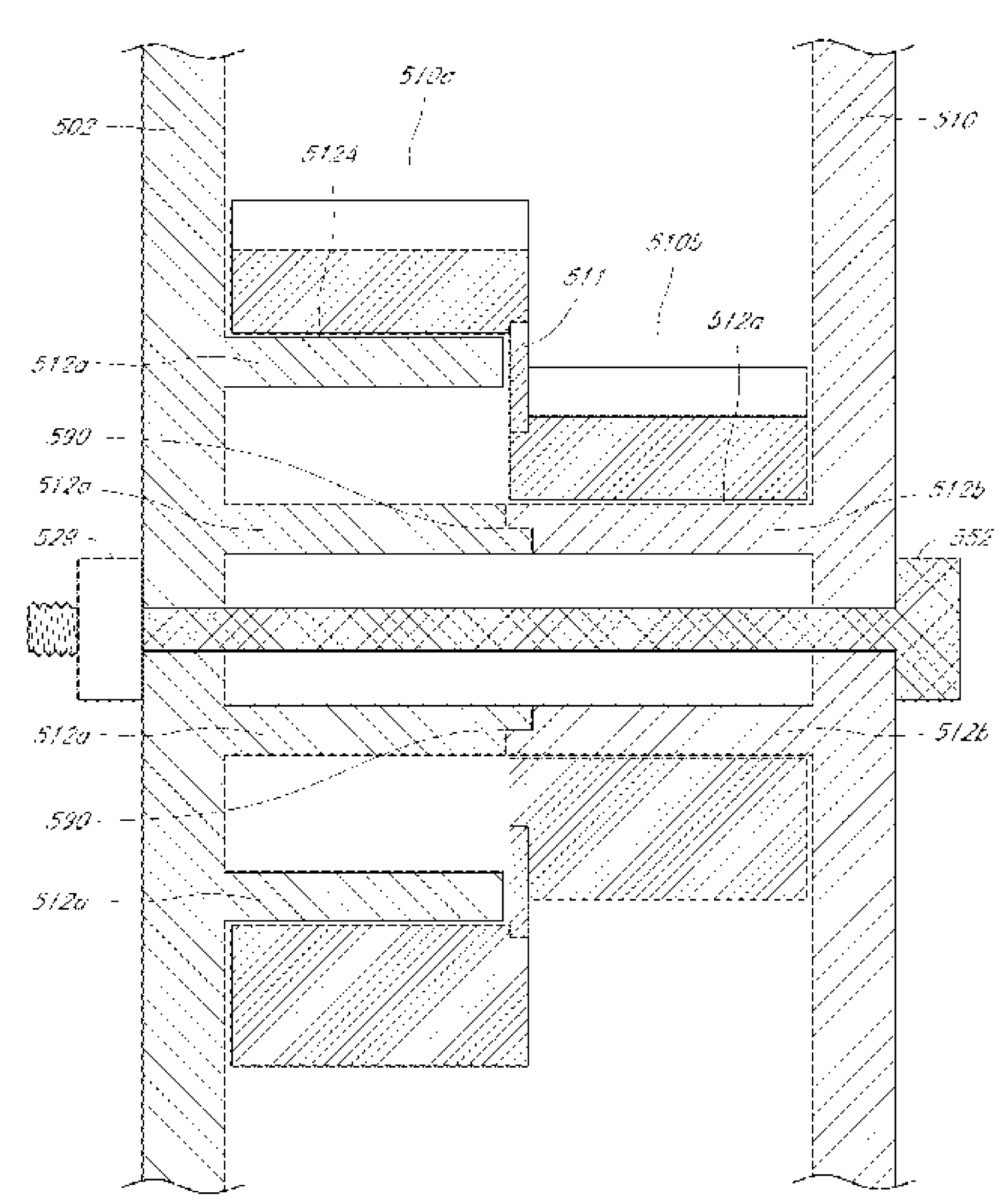
(57) **ABSTRACT**

A valvetrain conversion kit for an engine can comprises at least one timing idler rim gear configured to be meshed with at least one of a crank gear of the engine and a cam gear of the engine. The kit can include a first timing gear chamber member having a plurality of engine mounting locations corresponding to a plurality of corresponding cover mounting locations on an internal combustion engine body. The first timing gear chamber member can be configured to be rigidly attached to an engine body at the plurality of engine mounting locations. The first timing gear chamber member can also include a timing idler rim gear shaft supported by the interior surface, the timing idler rim gear shaft having an exterior shaft surface where the exterior shaft surface is configured for rotatably supporting the timing idler rim gear.

22 Claims, 23 Drawing Sheets



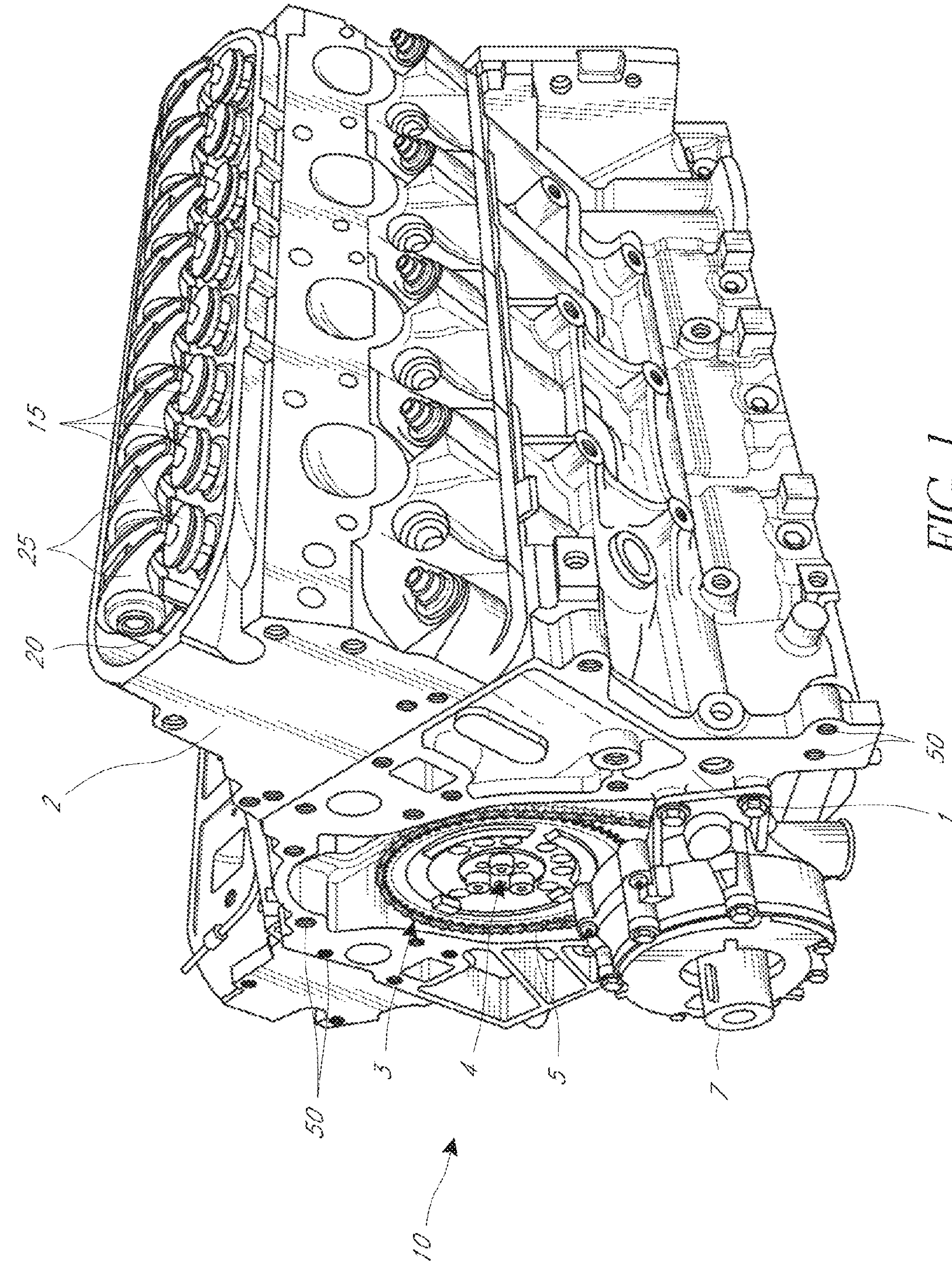


FIG. 1
(Prior Art)

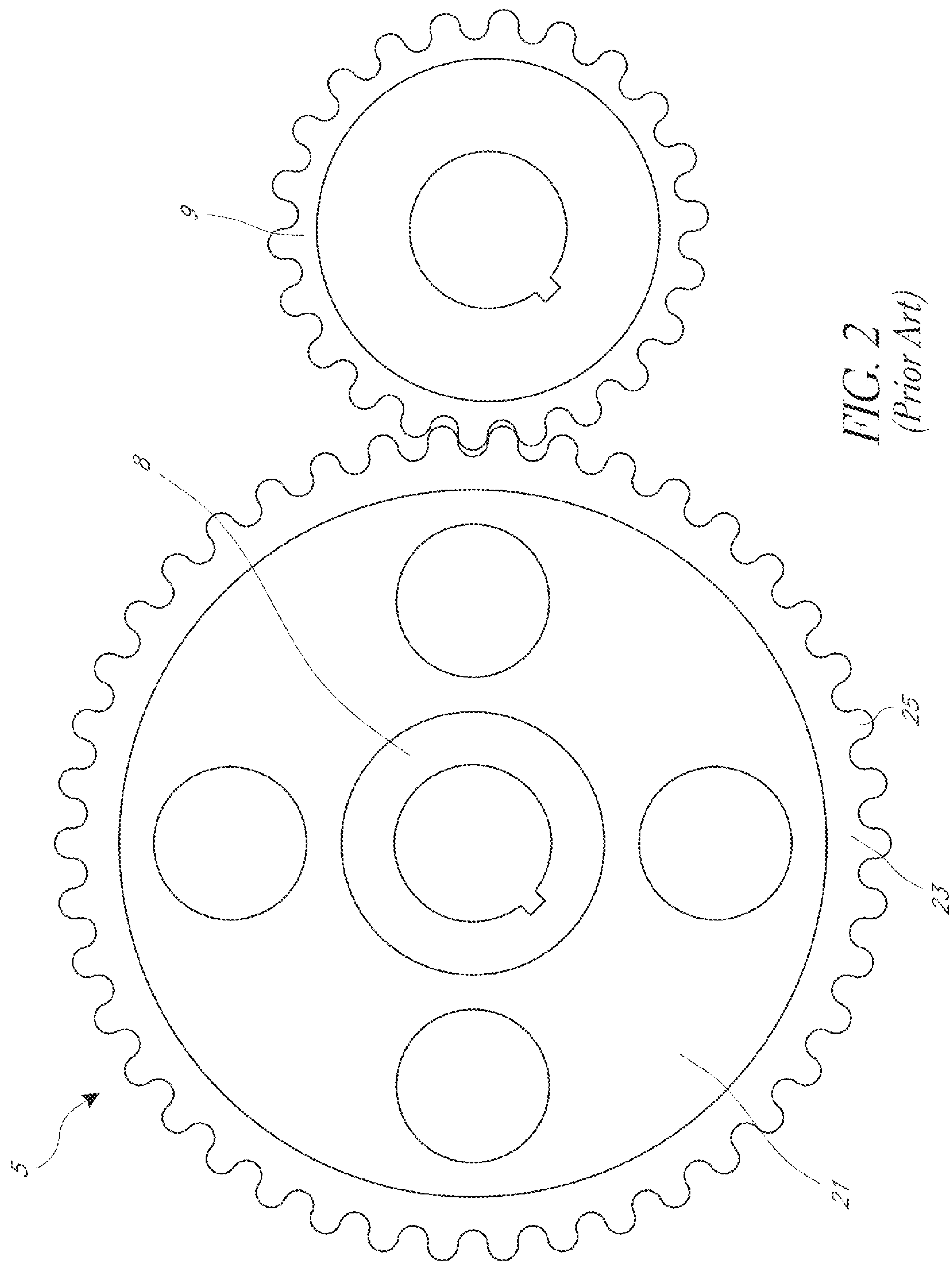


FIG. 2
(Prior Art)

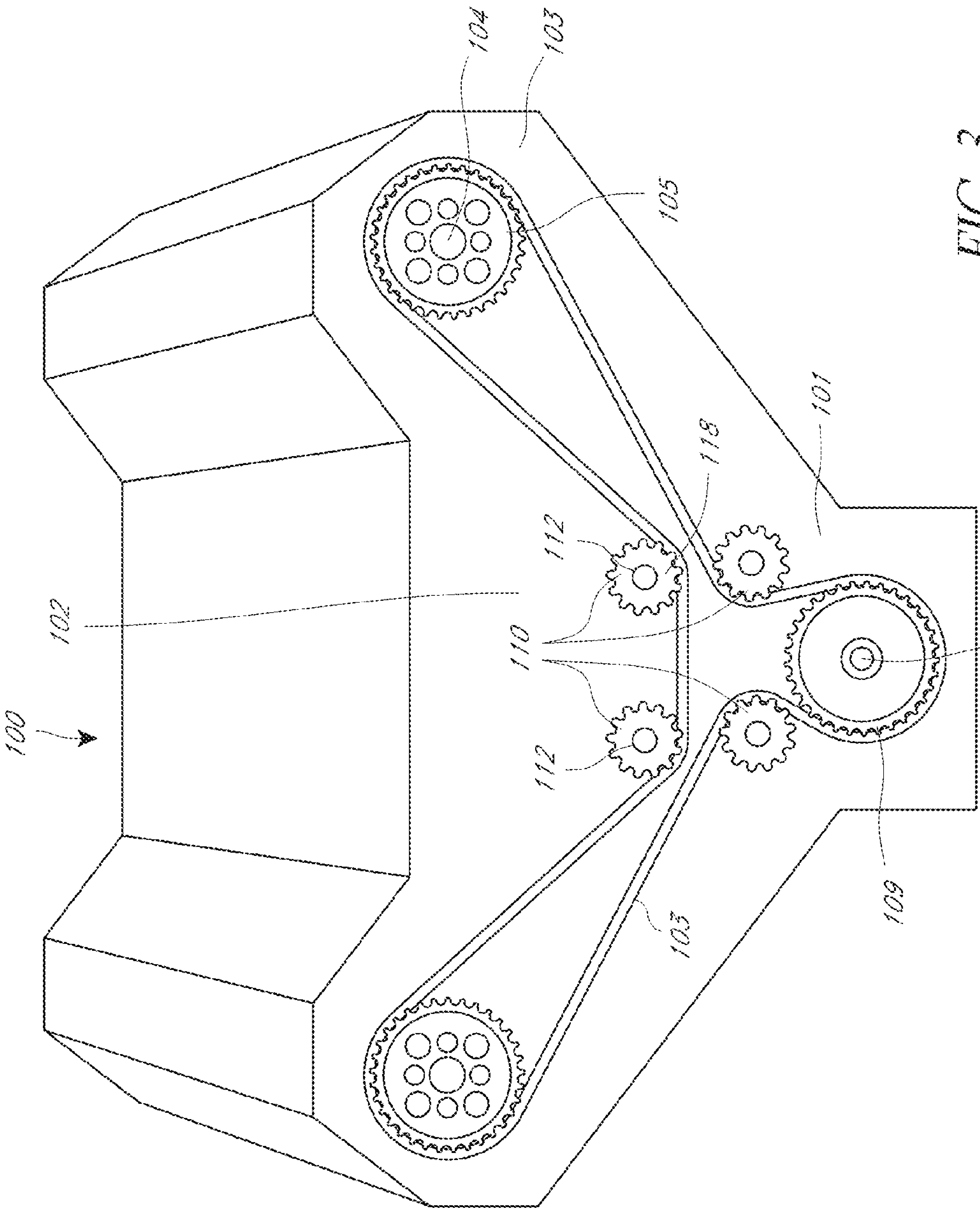


FIG. 3
(Prior Art)

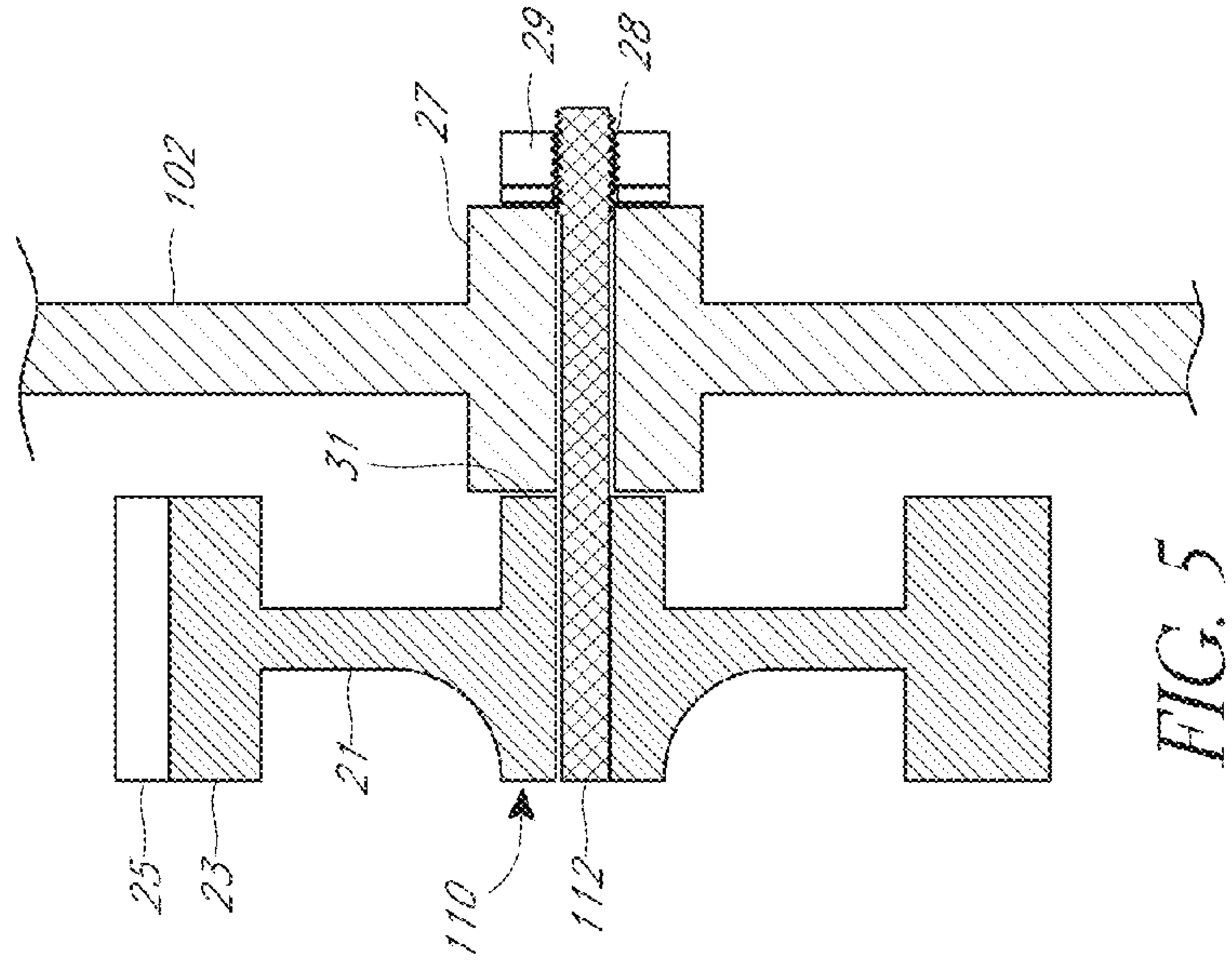


FIG. 5

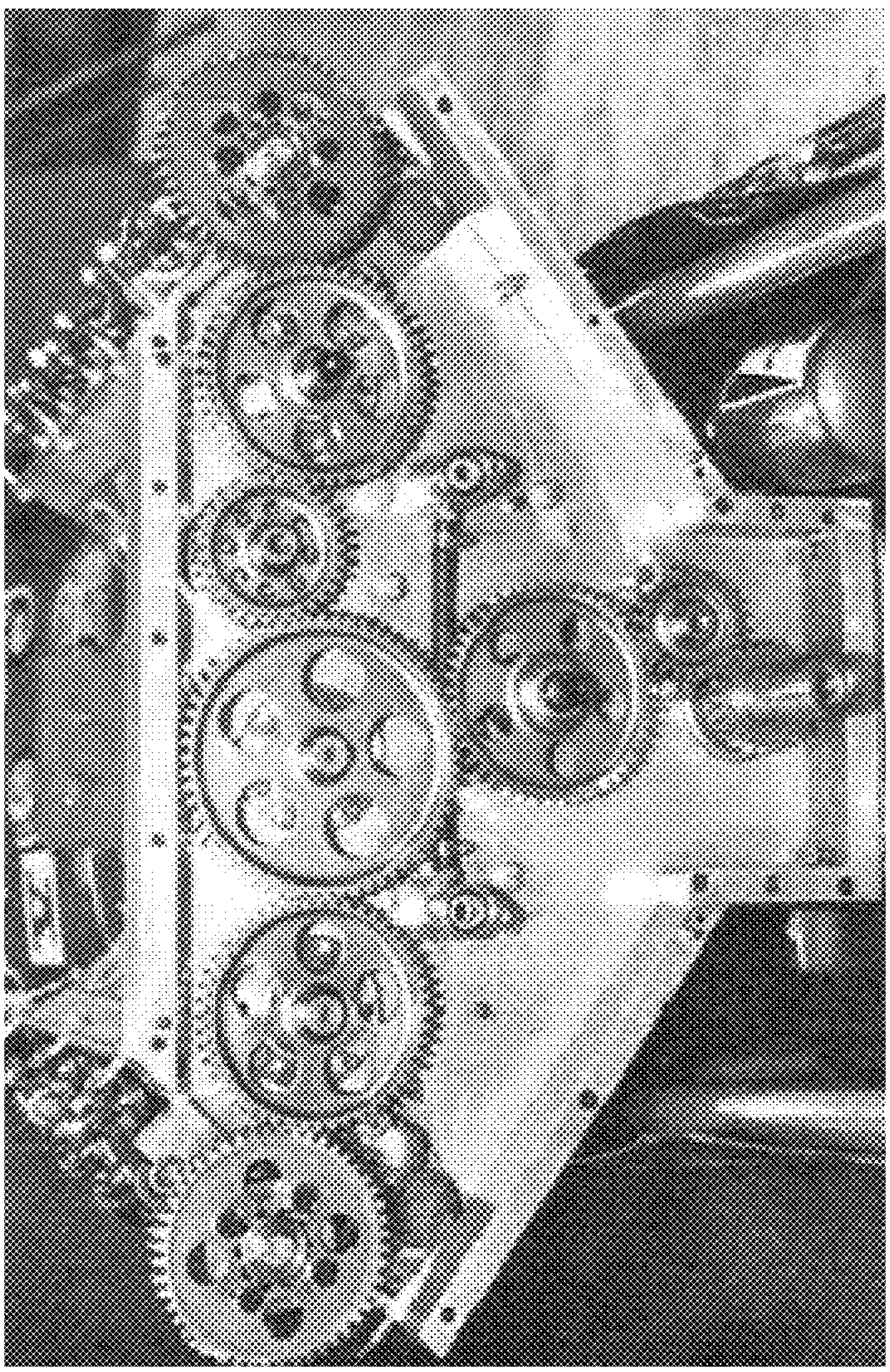
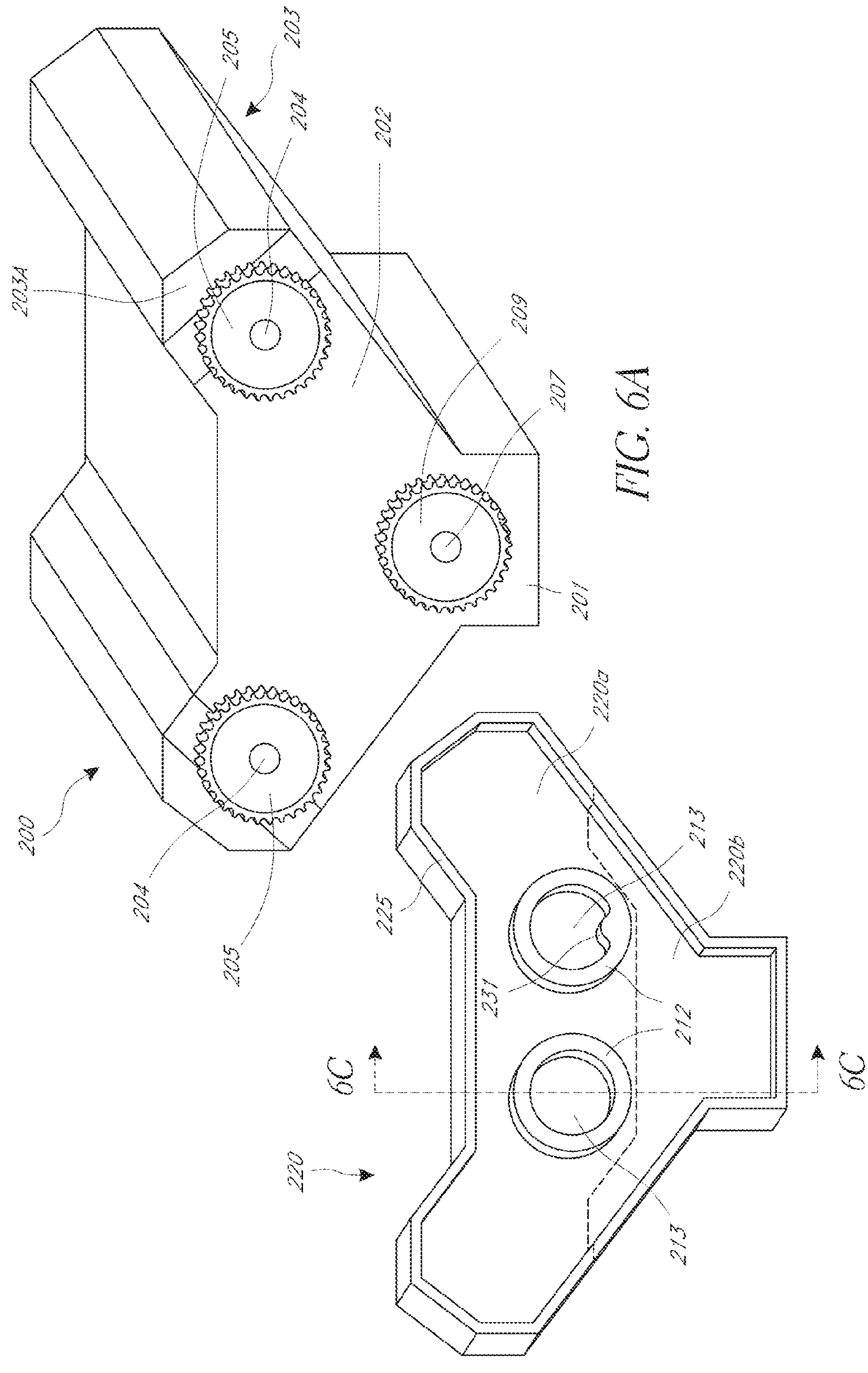


FIG. 4
(Prior Art)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203A
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220b
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212
212
6C
6C
220
213

FIG. 6A

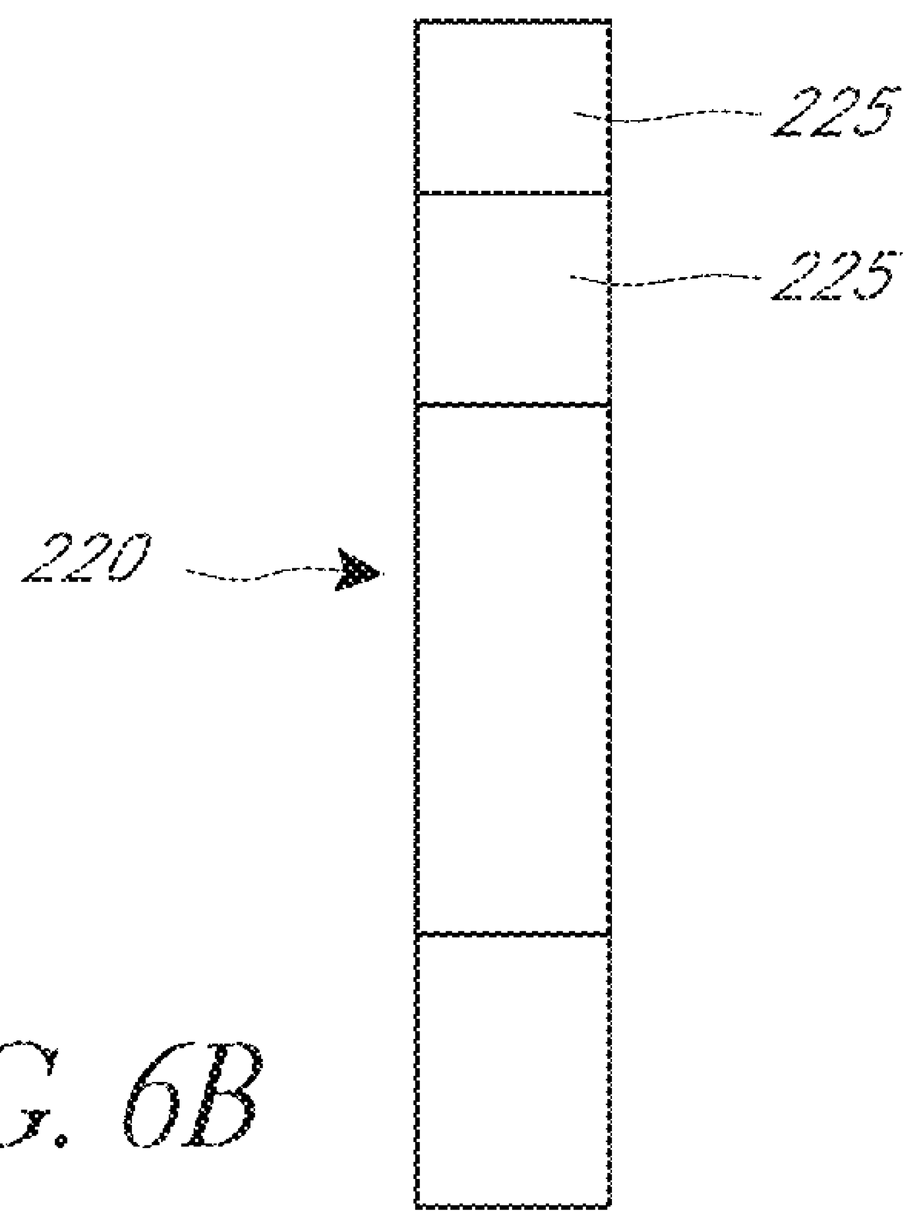


FIG. 6B

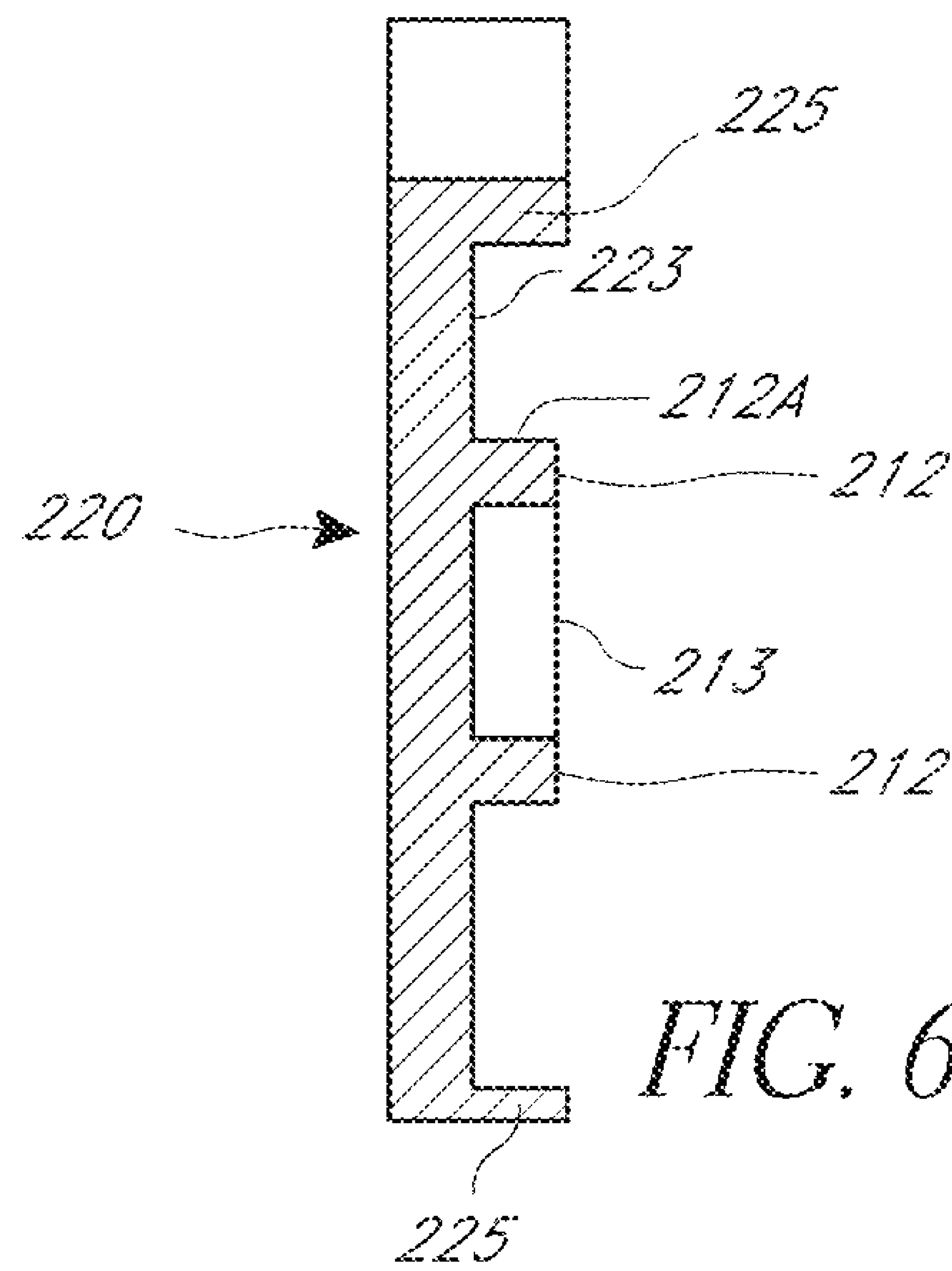


FIG. 6C

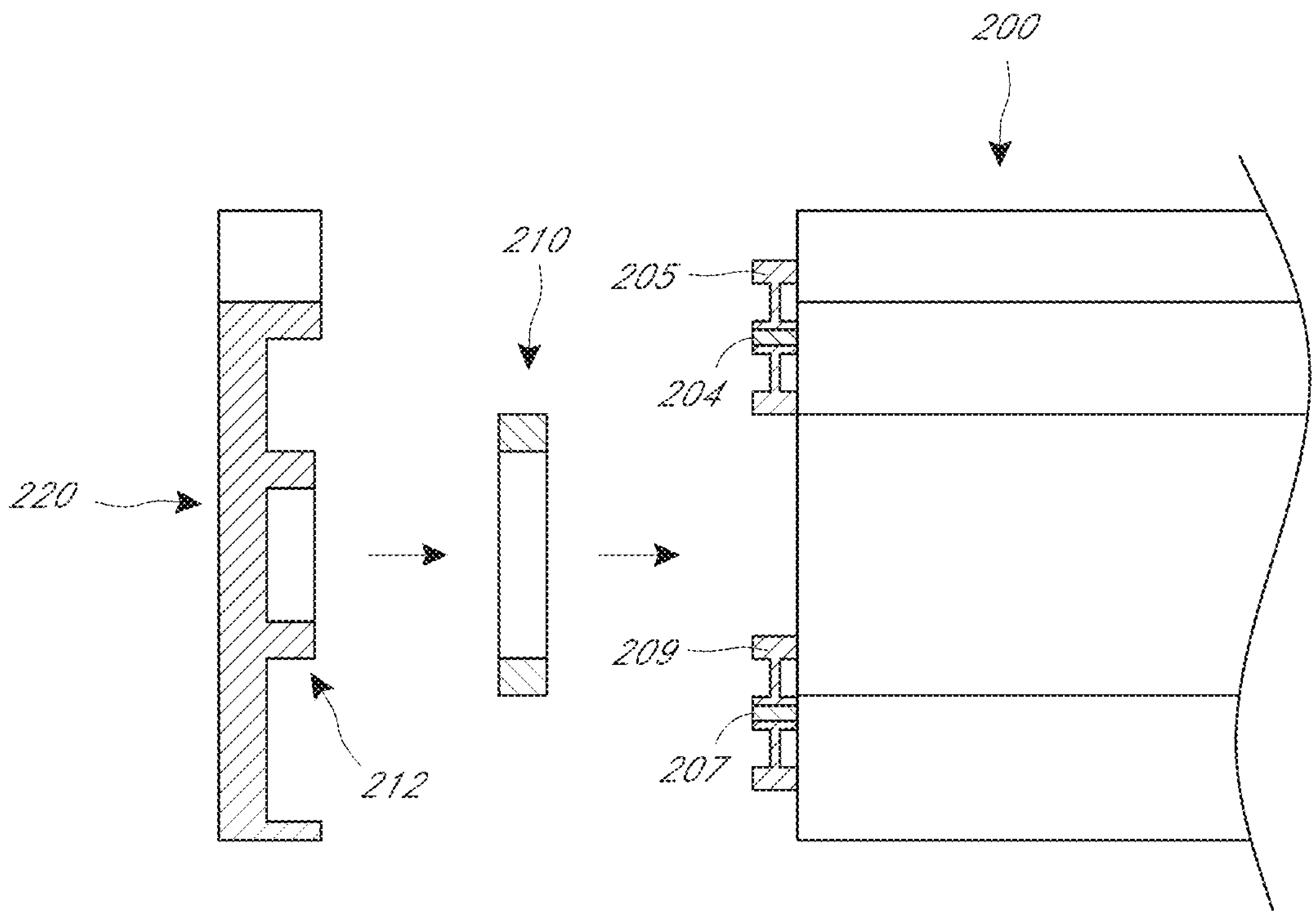


FIG. 6D

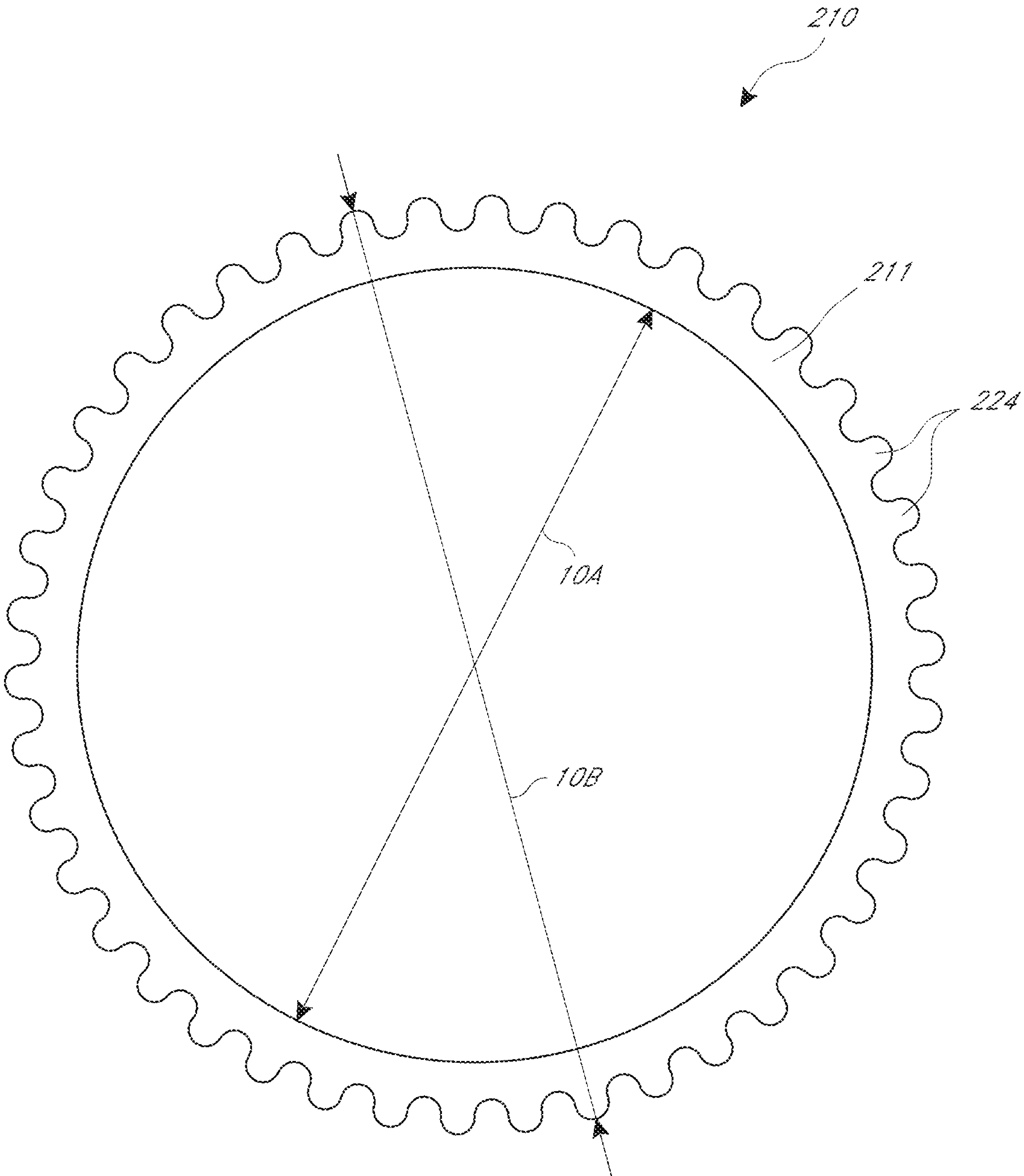


FIG. 6E

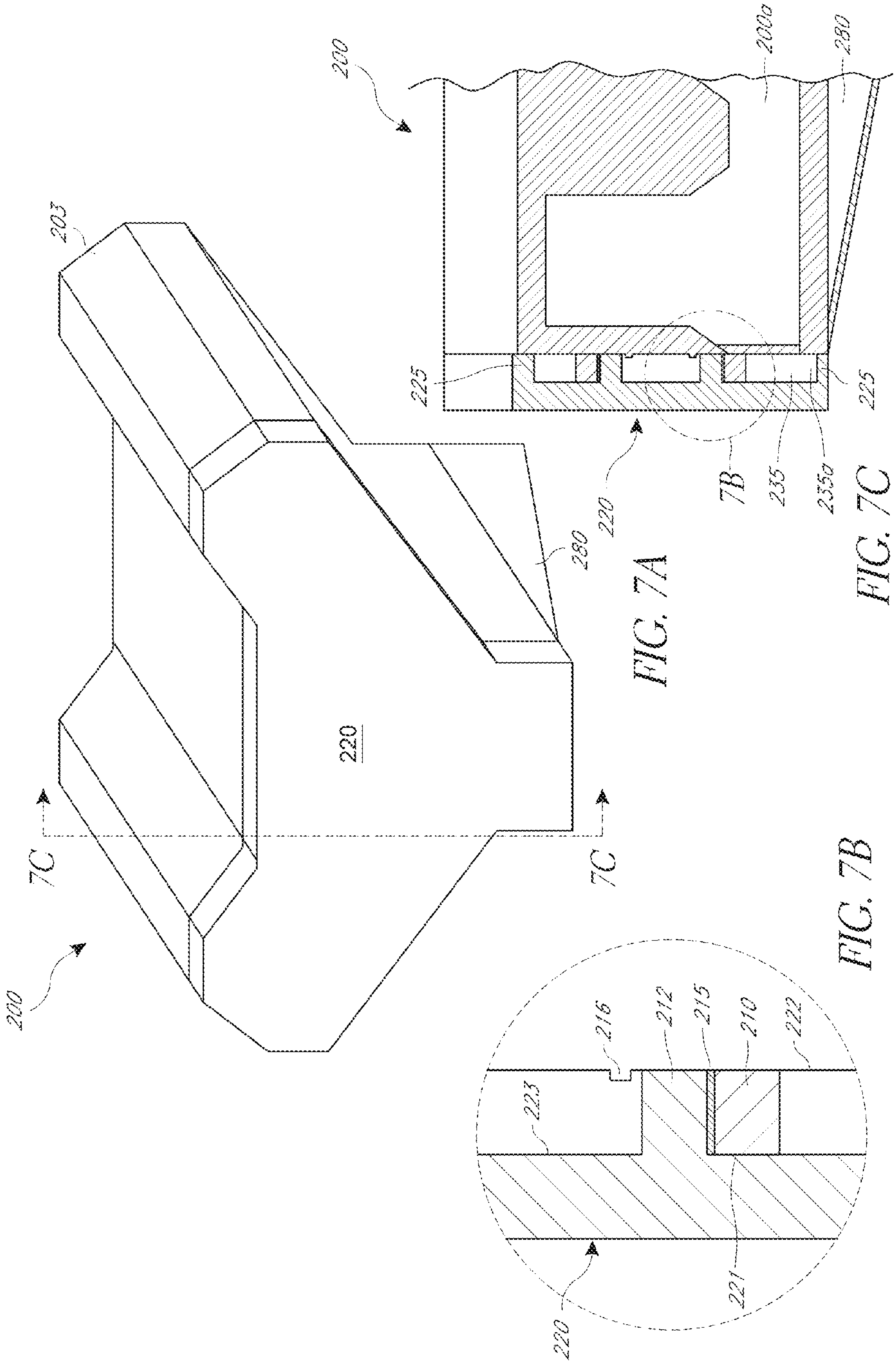
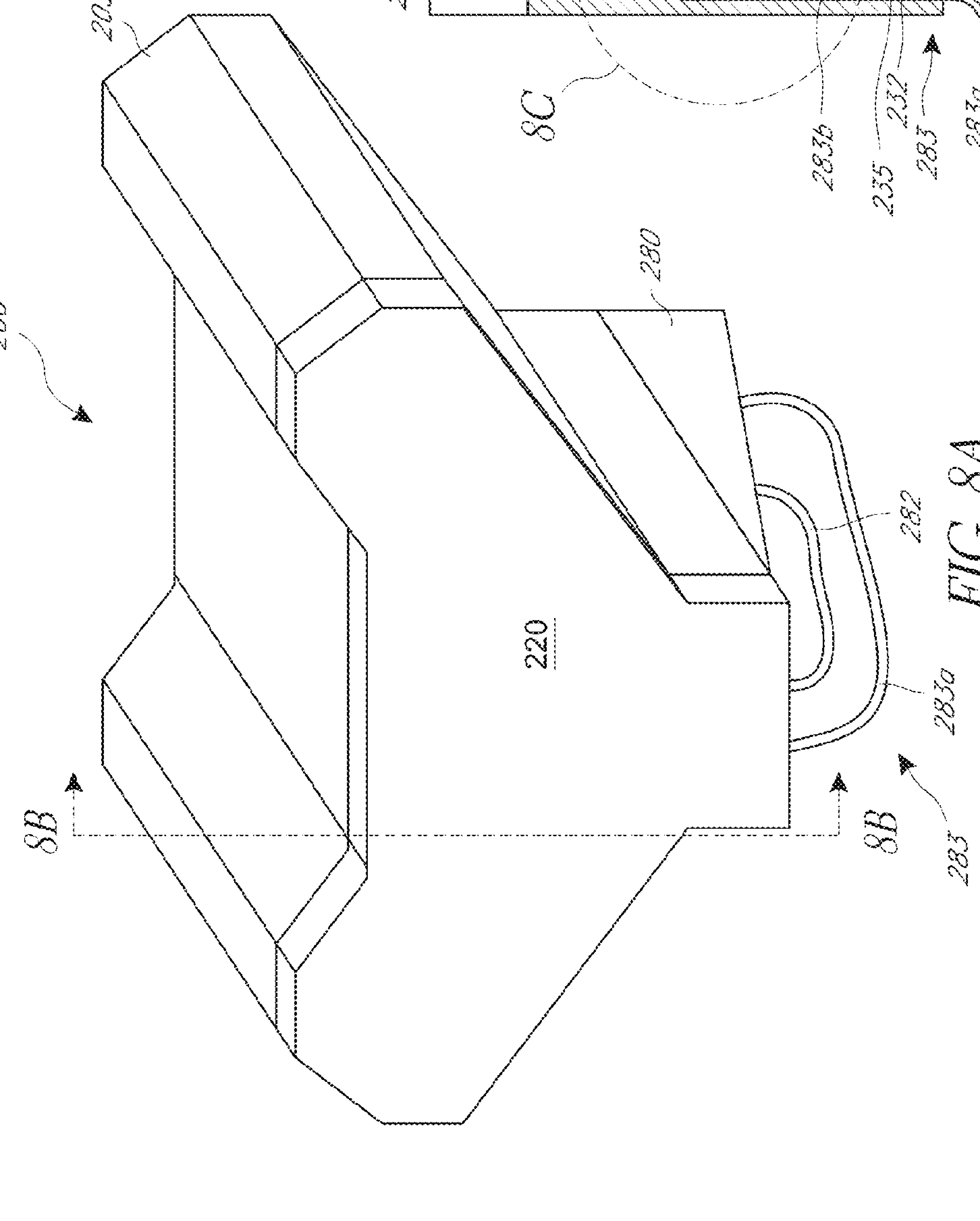


FIG. 7A

FIG. 7B

FIG. 7C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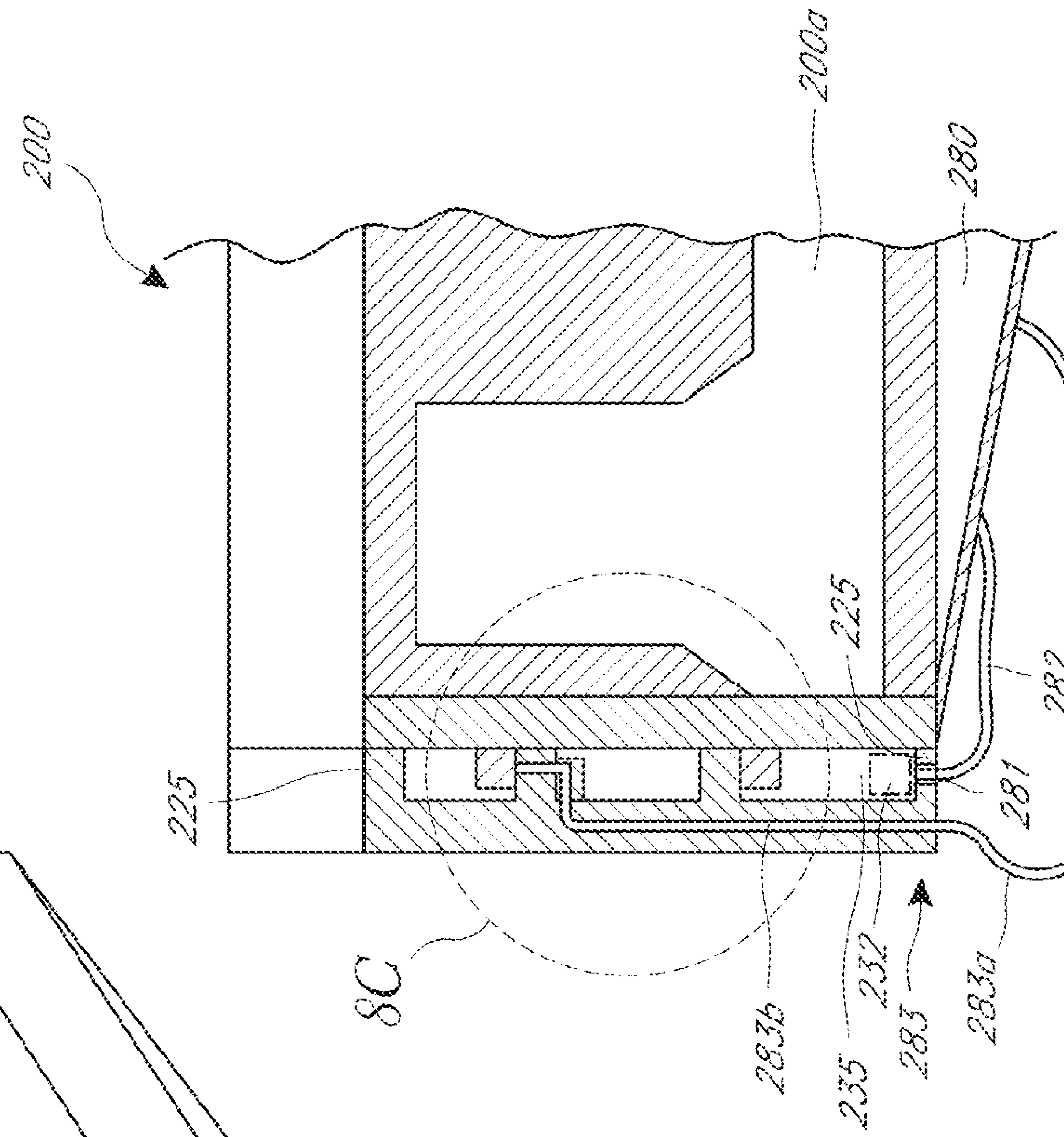
8B
8B

FIG. 8A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8C
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232
283
283a

FIG. 8B

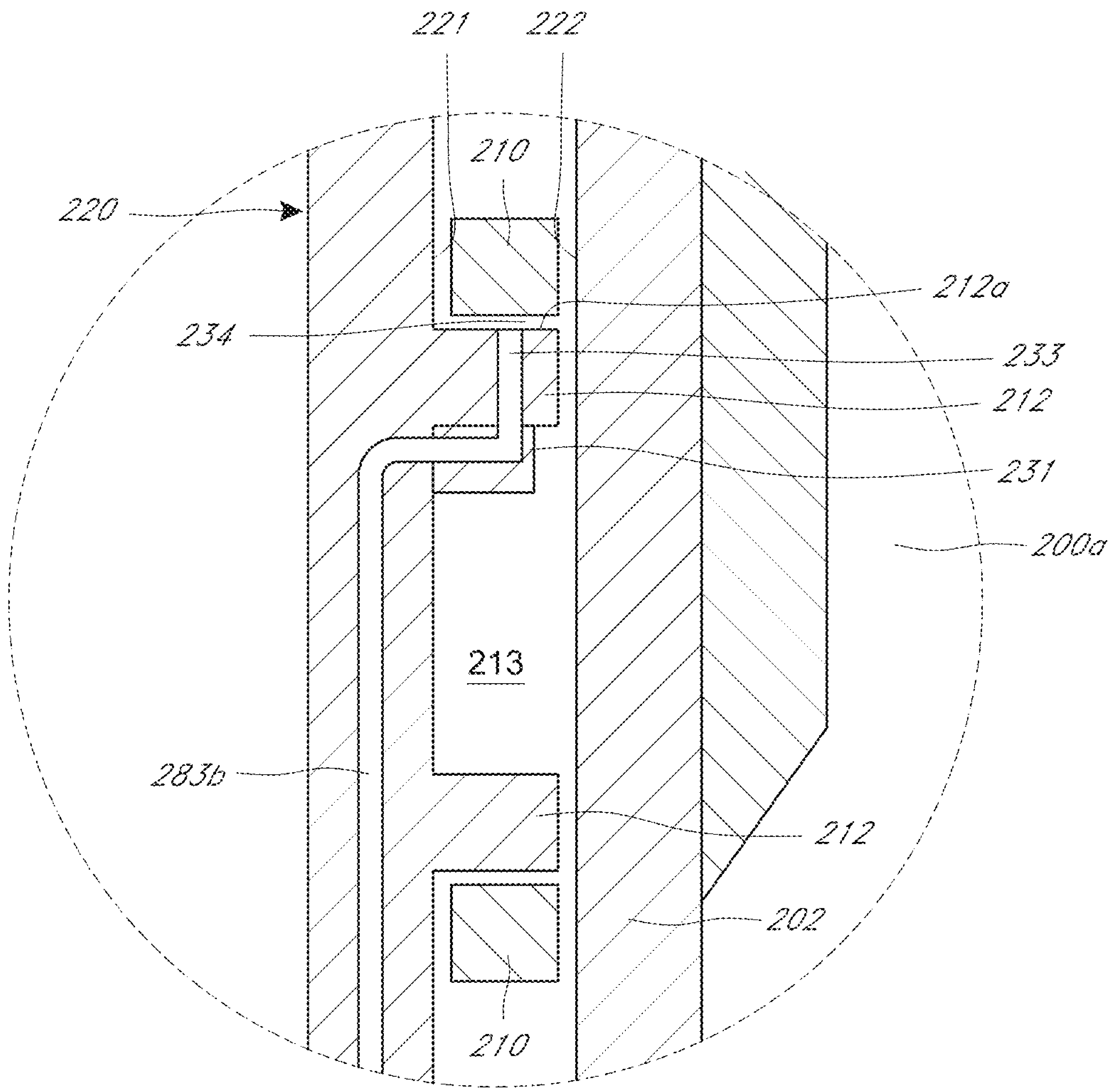
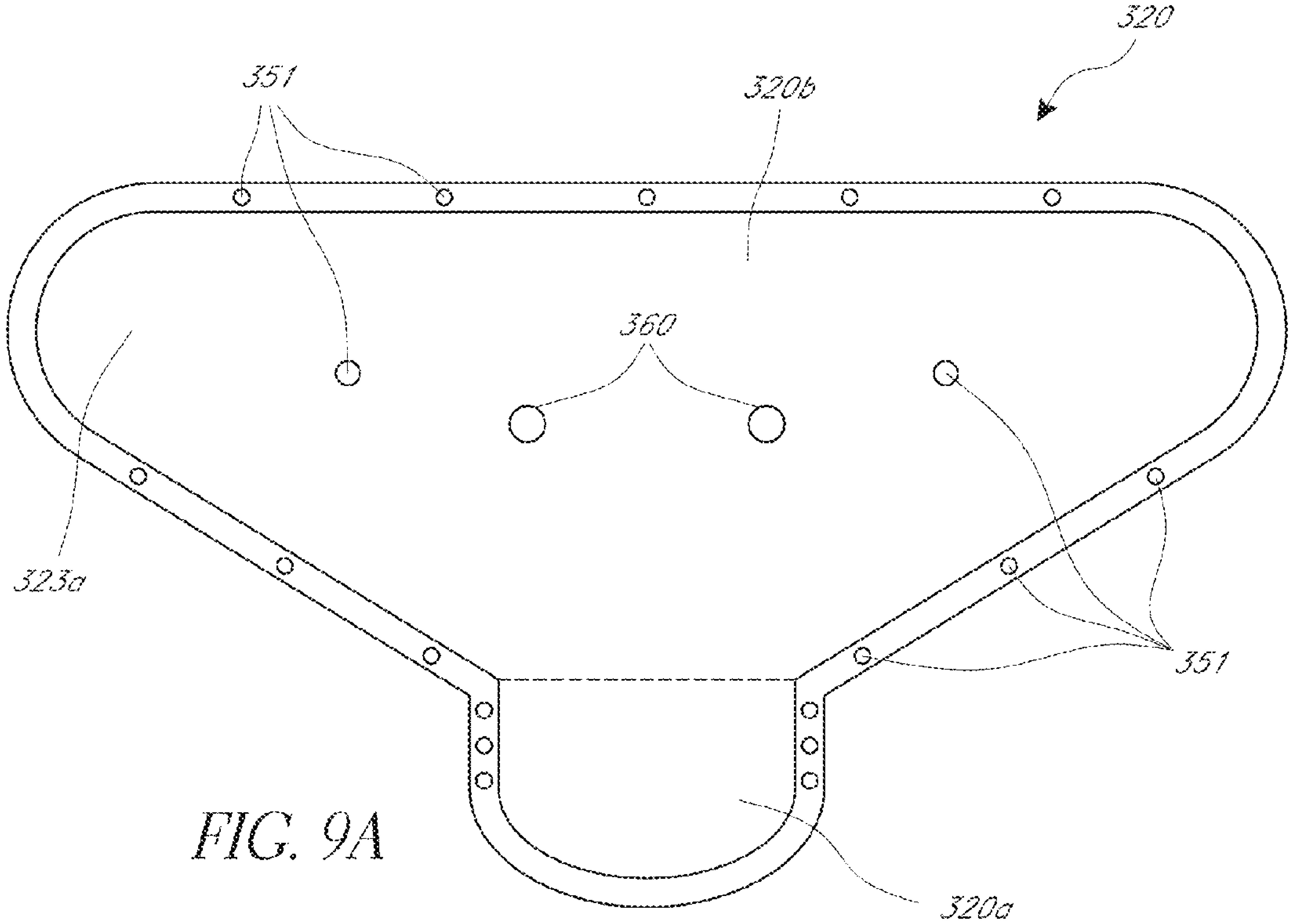


FIG. 8C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320a

FIG. 9A

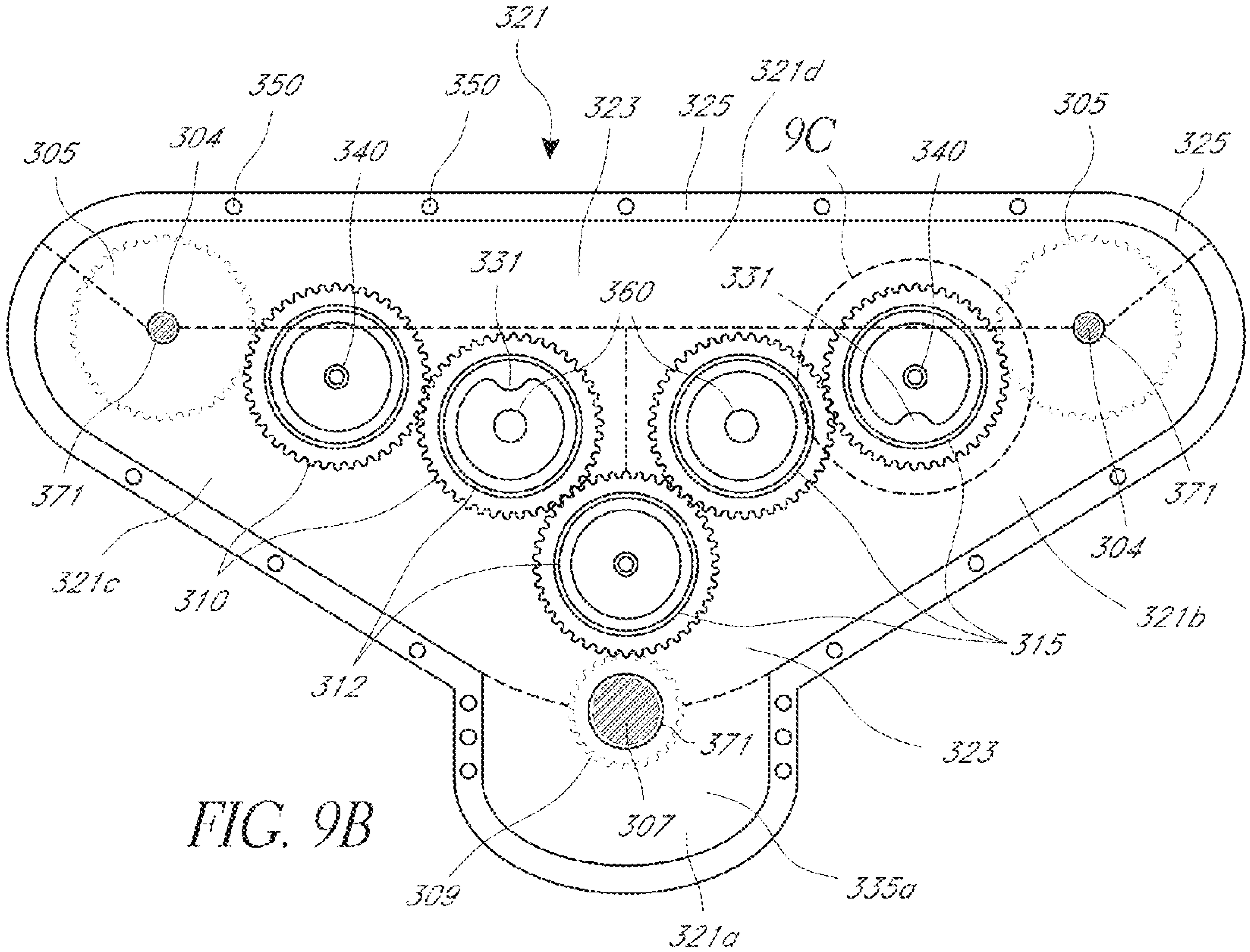
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FIG. 9B

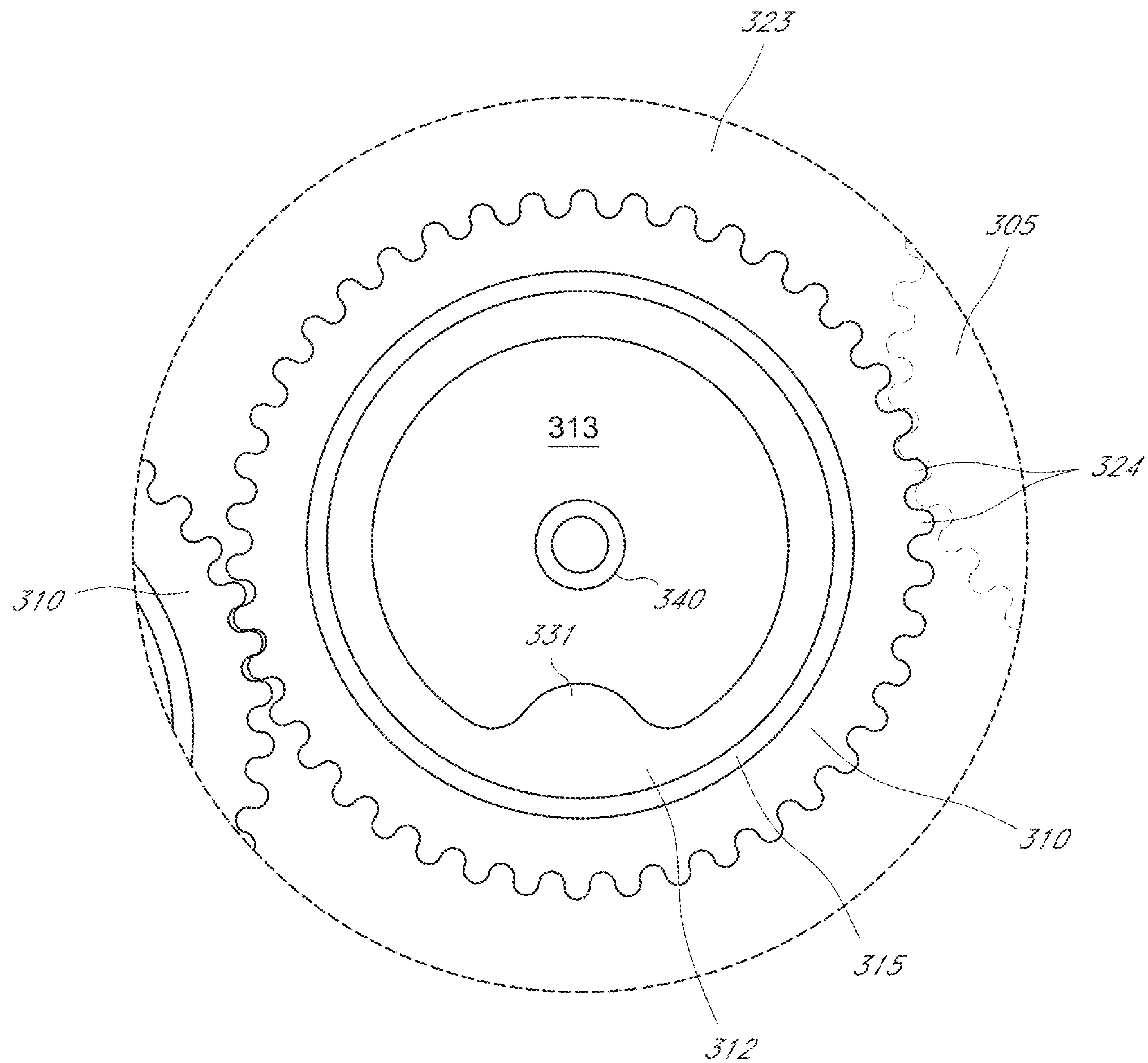


FIG. 9C

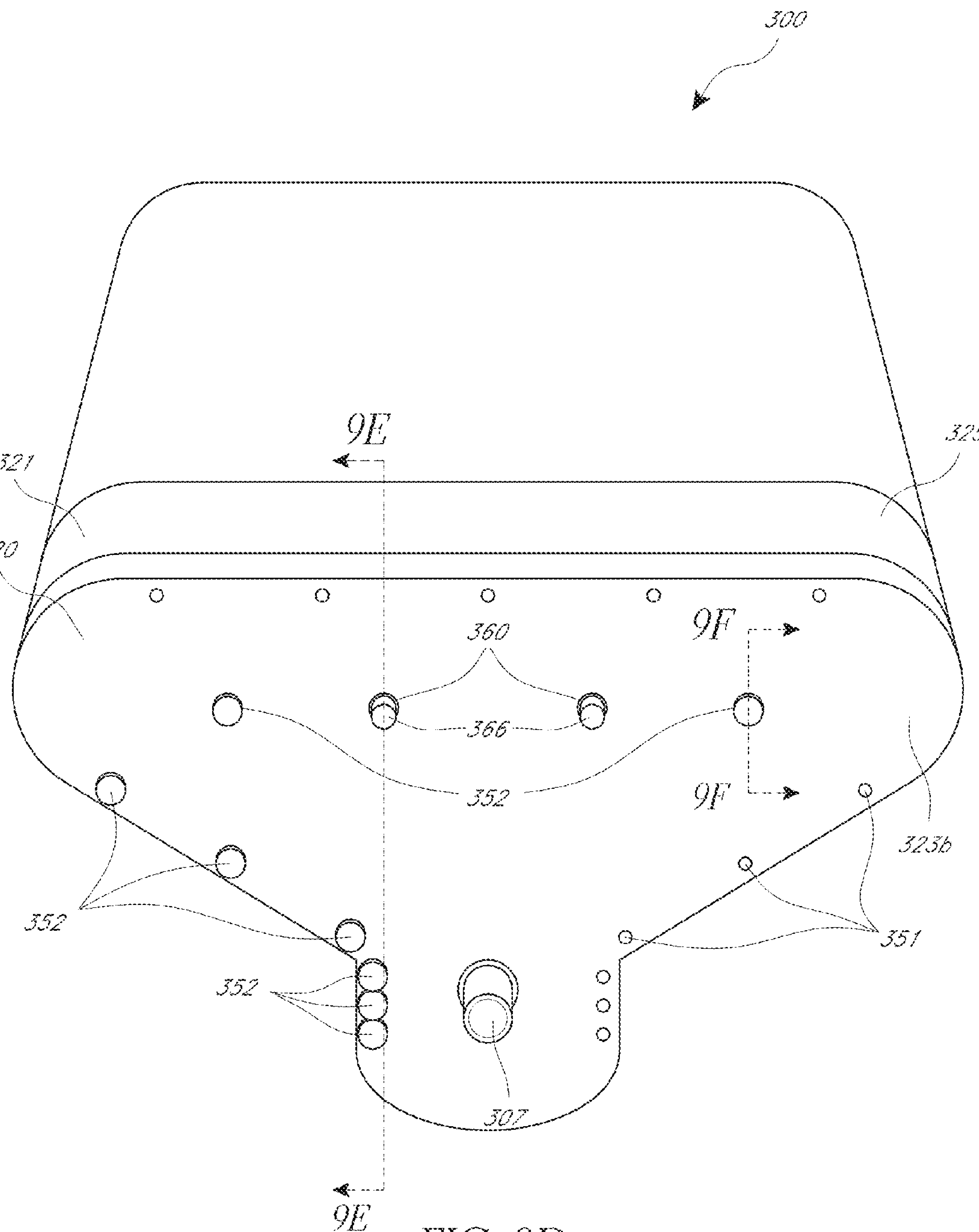
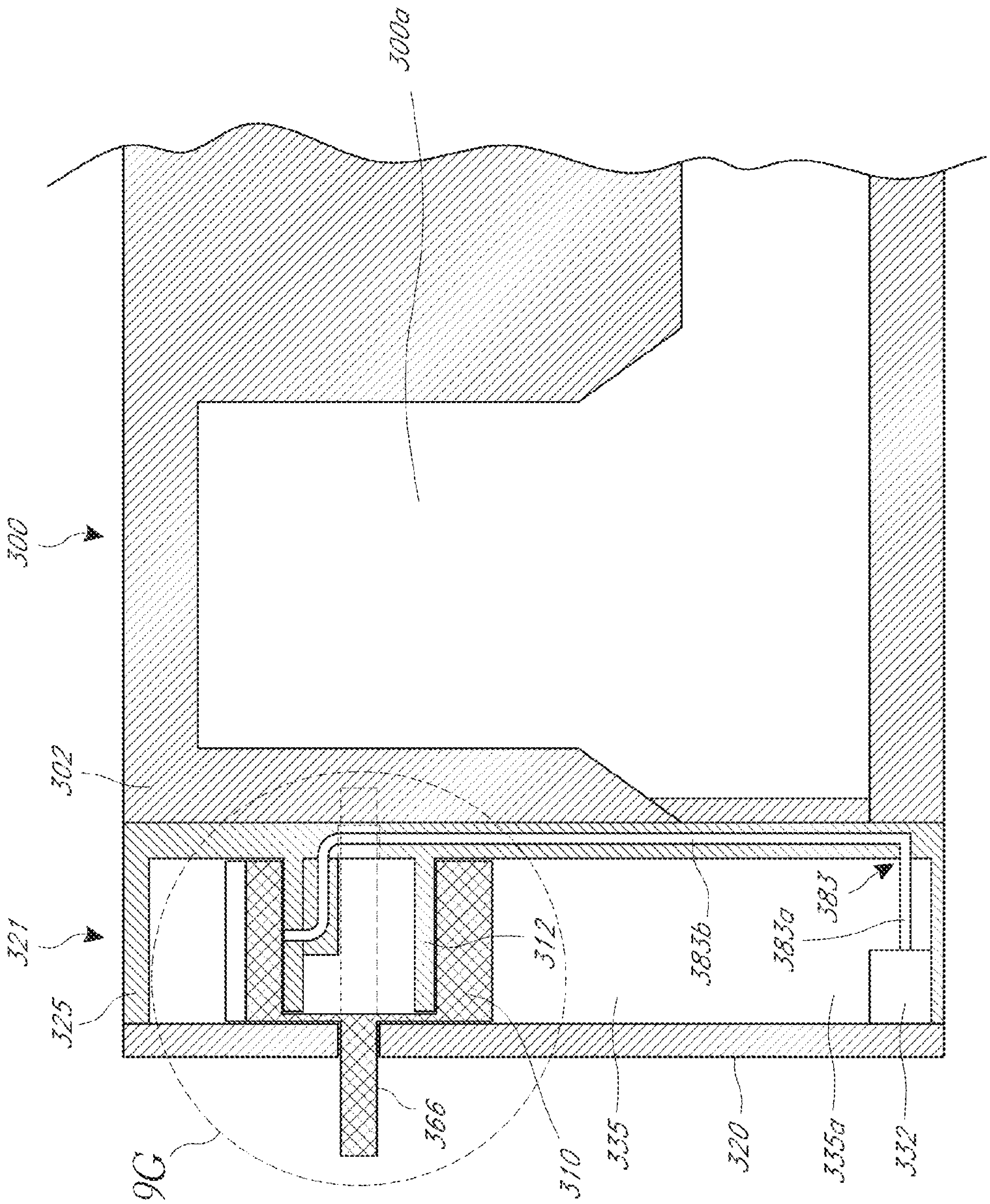


FIG. 9D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335
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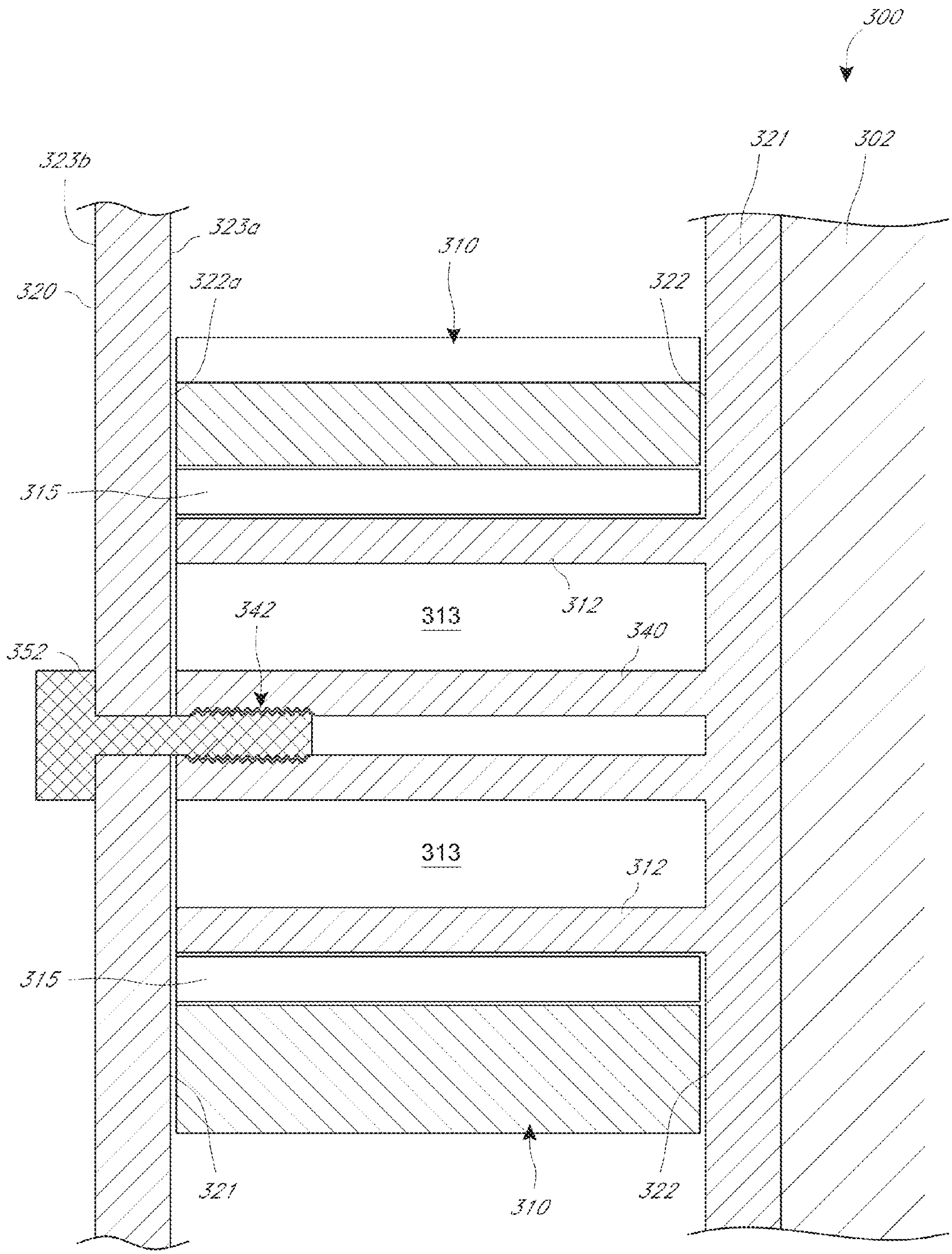
332
9G

FIG. 9E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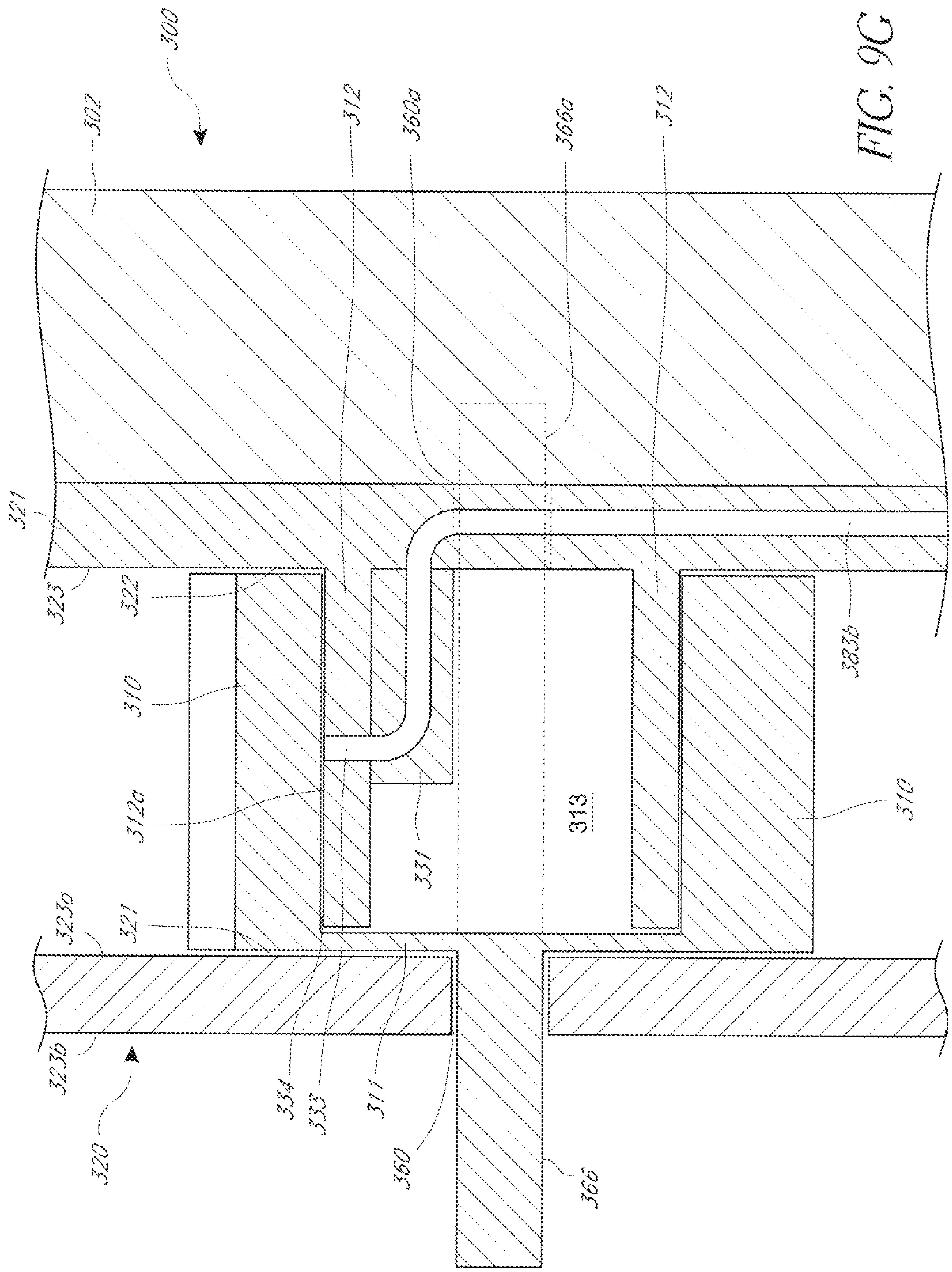
322

FIG. 9F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360
366

FIG. 9G

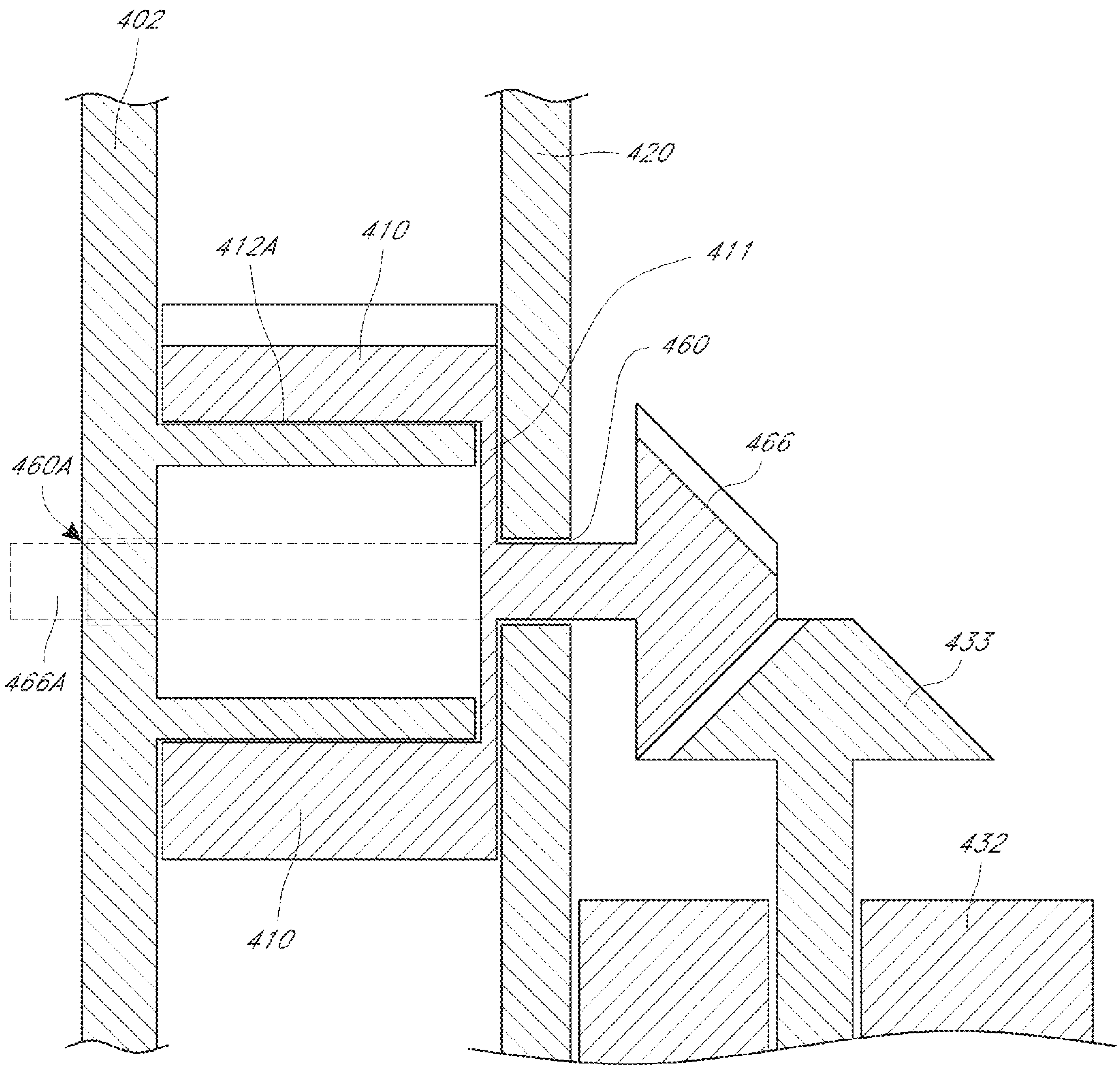

FIG. 10

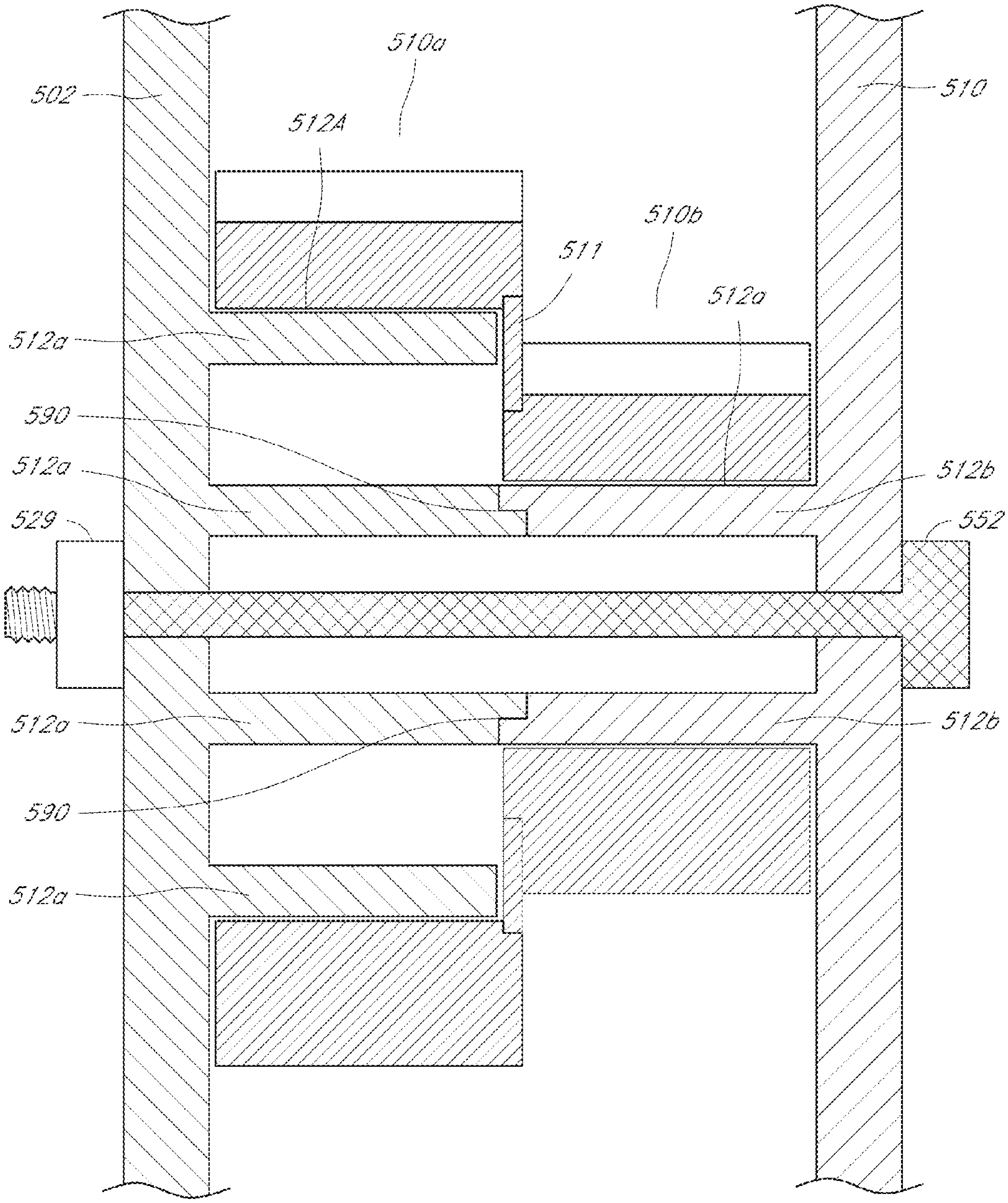
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FIG. 11

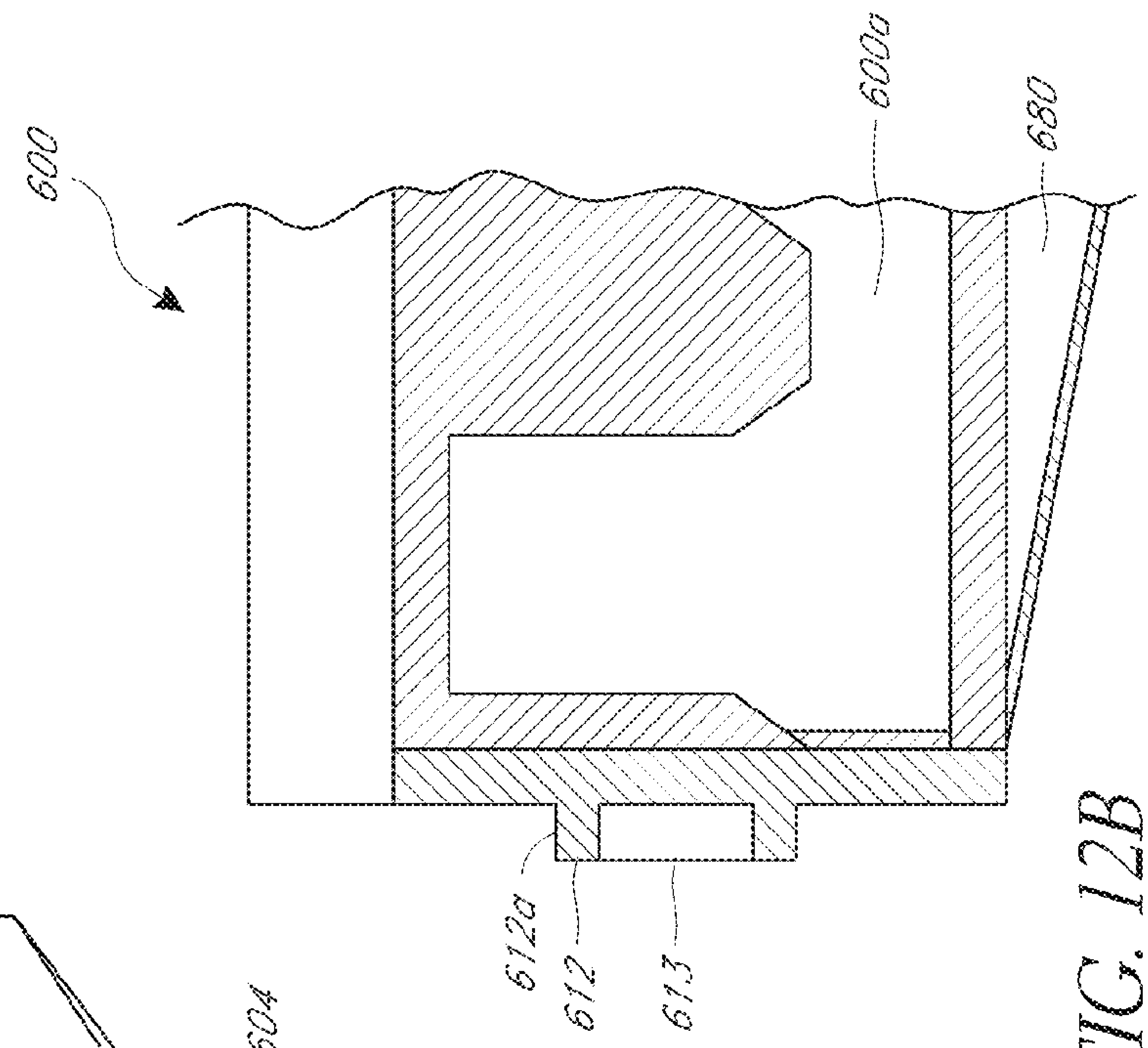


FIG. 12B

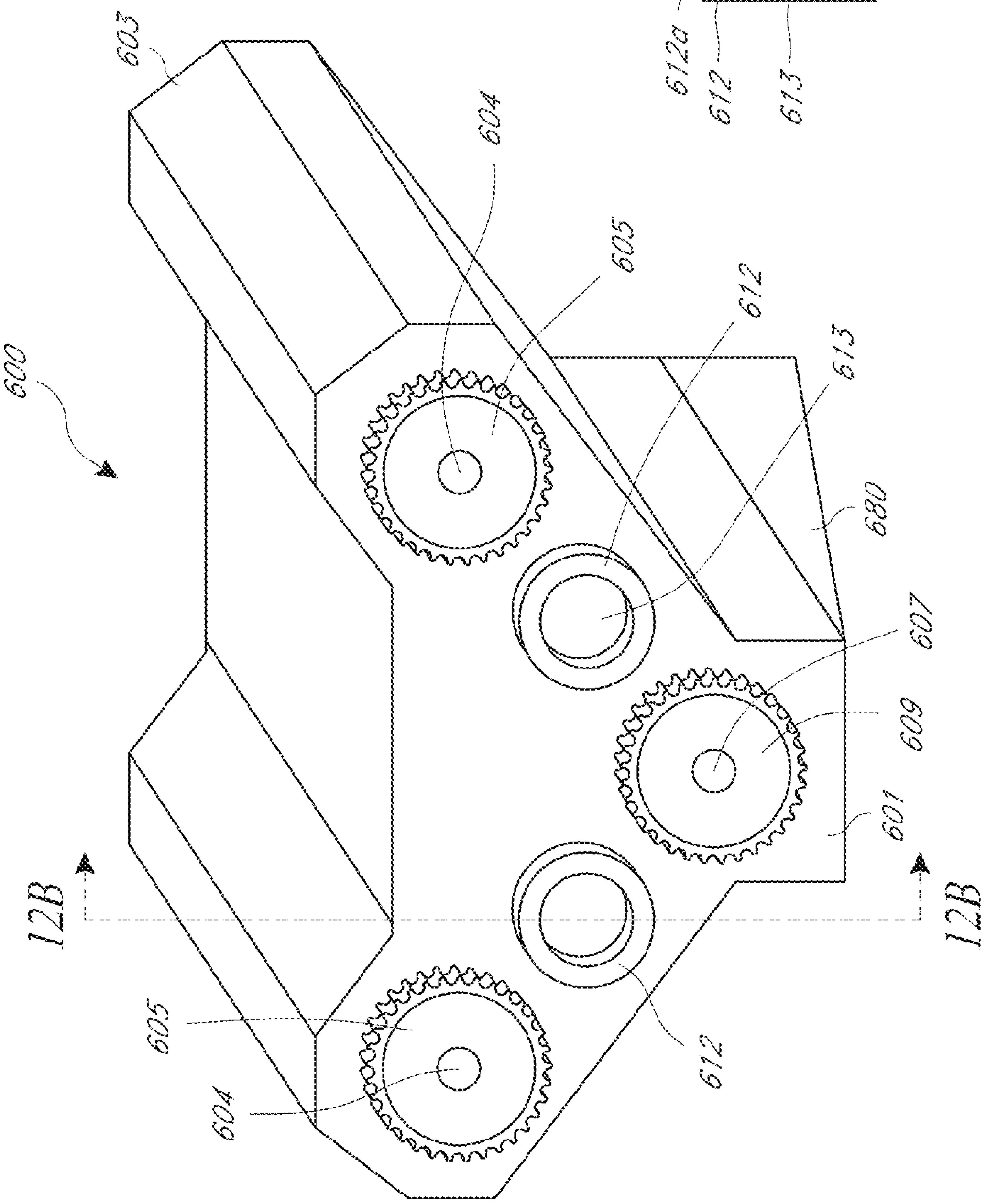


FIG. 12A

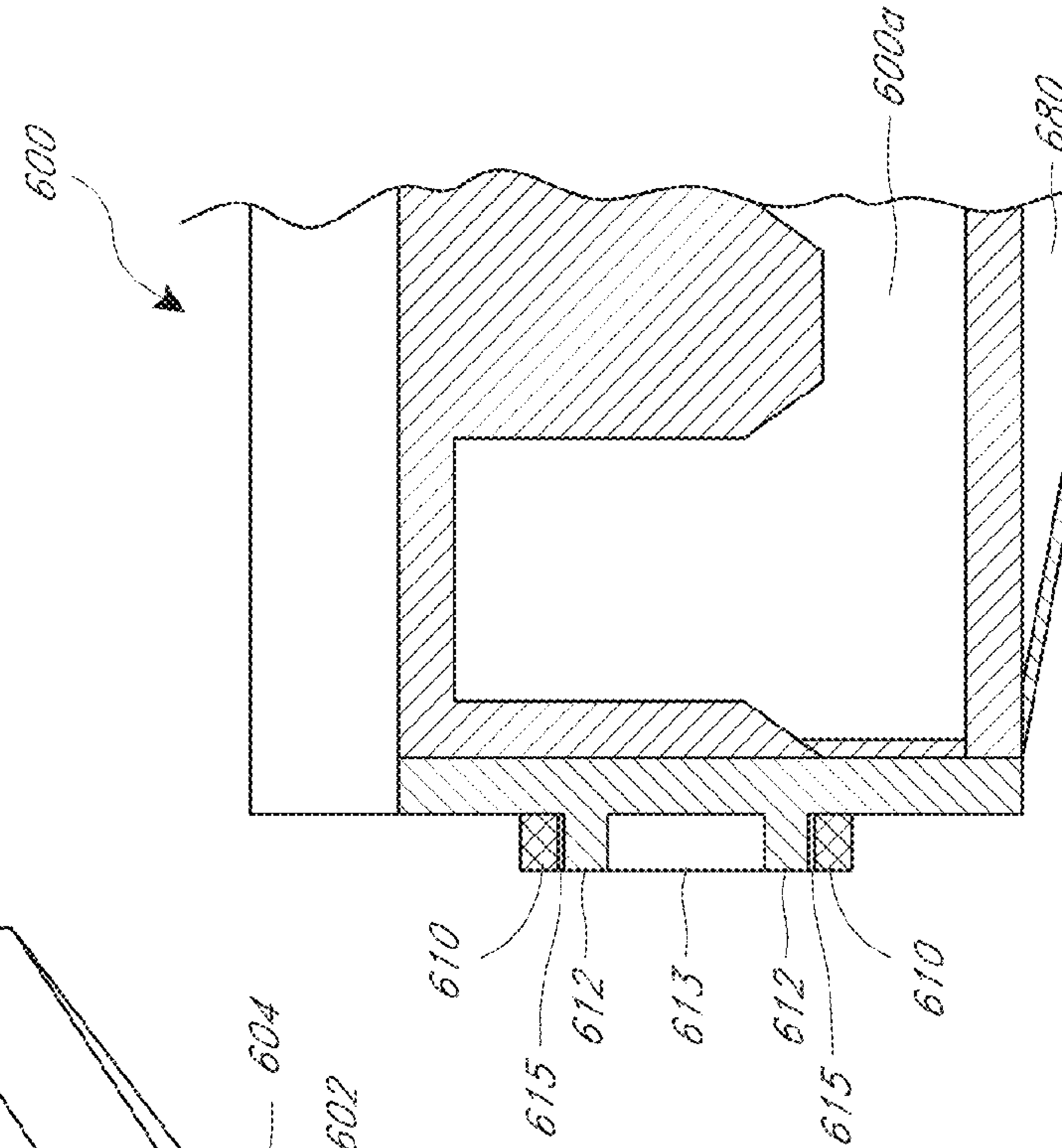


FIG. 13B

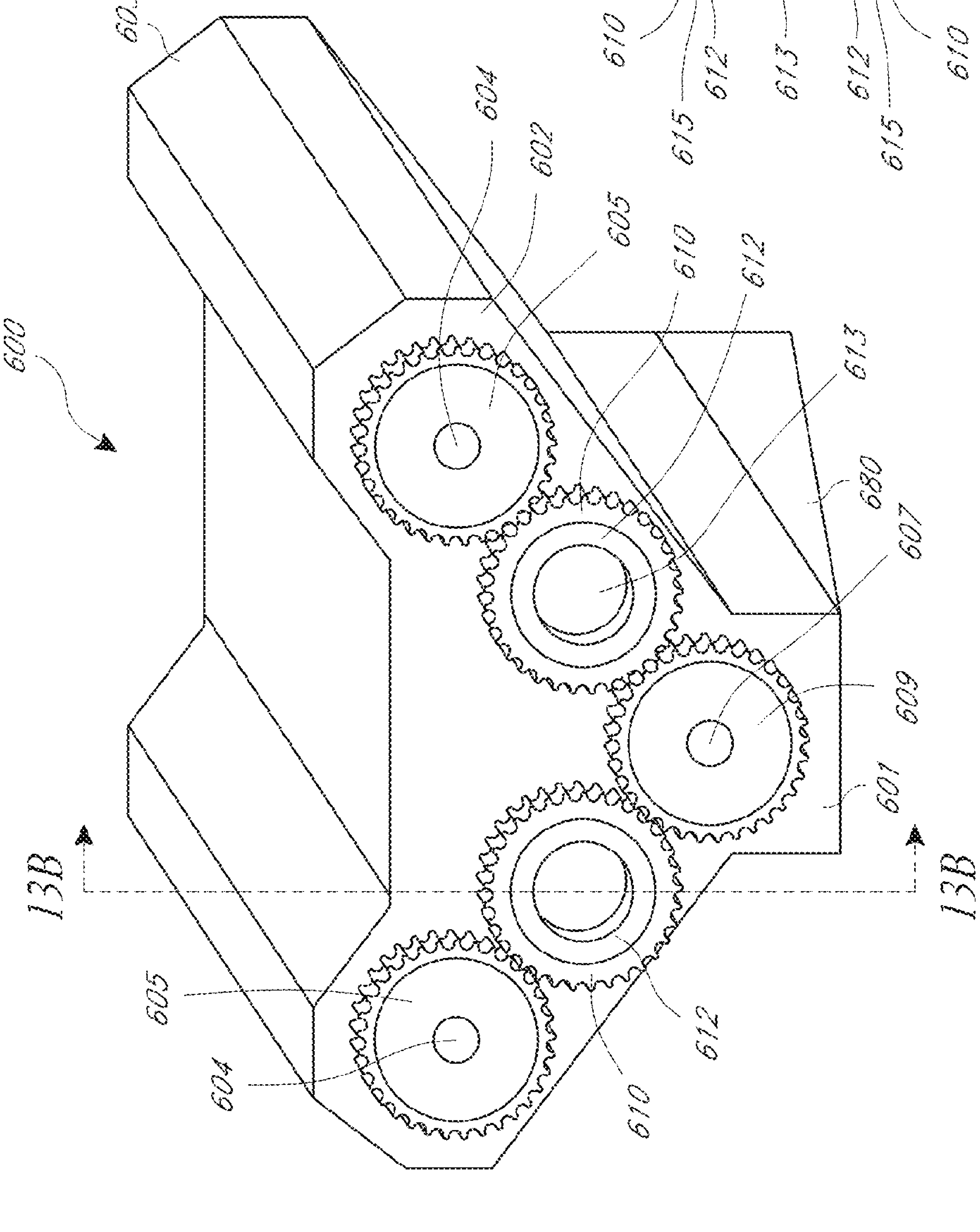


FIG. 13A

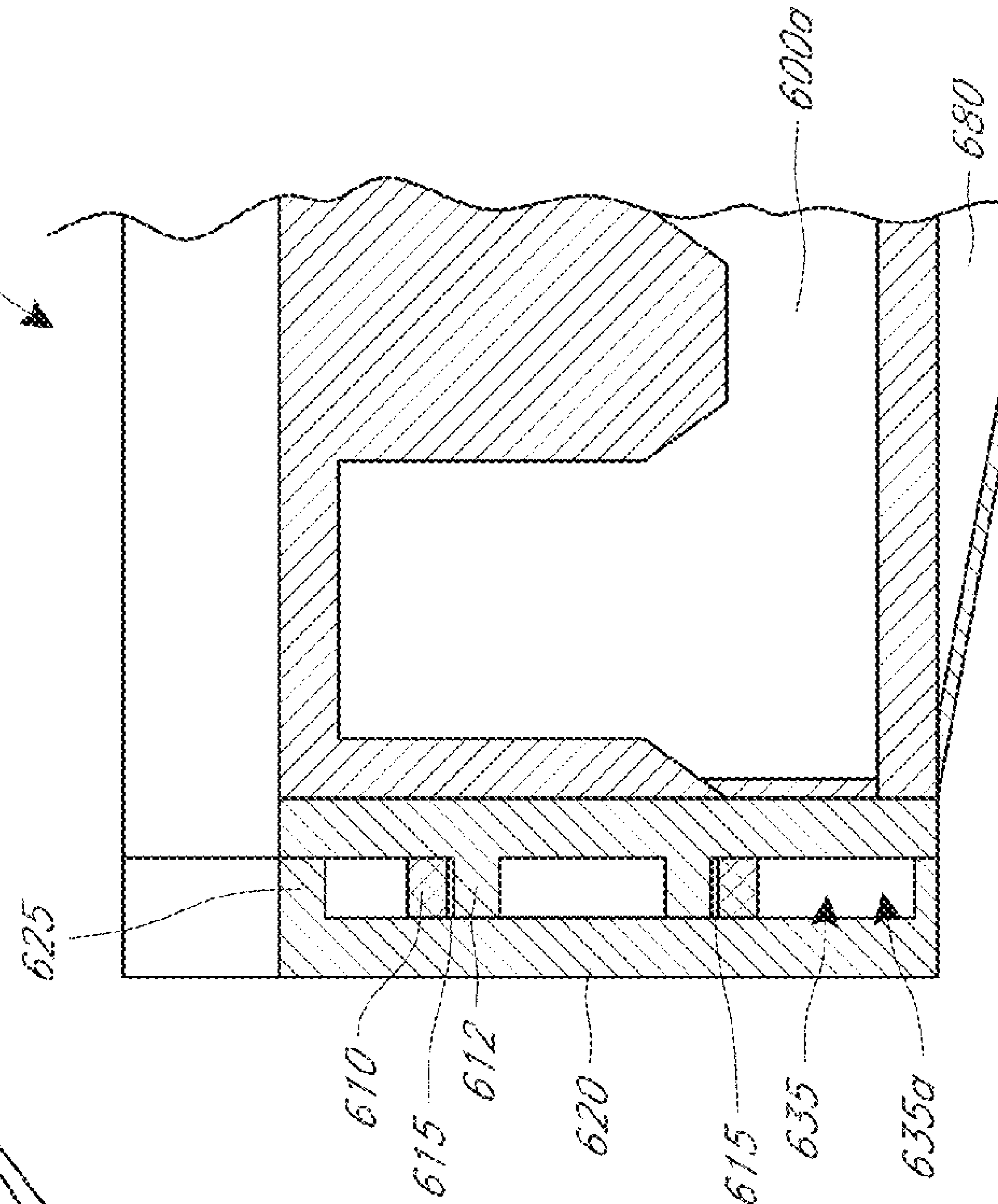


FIG. 14B

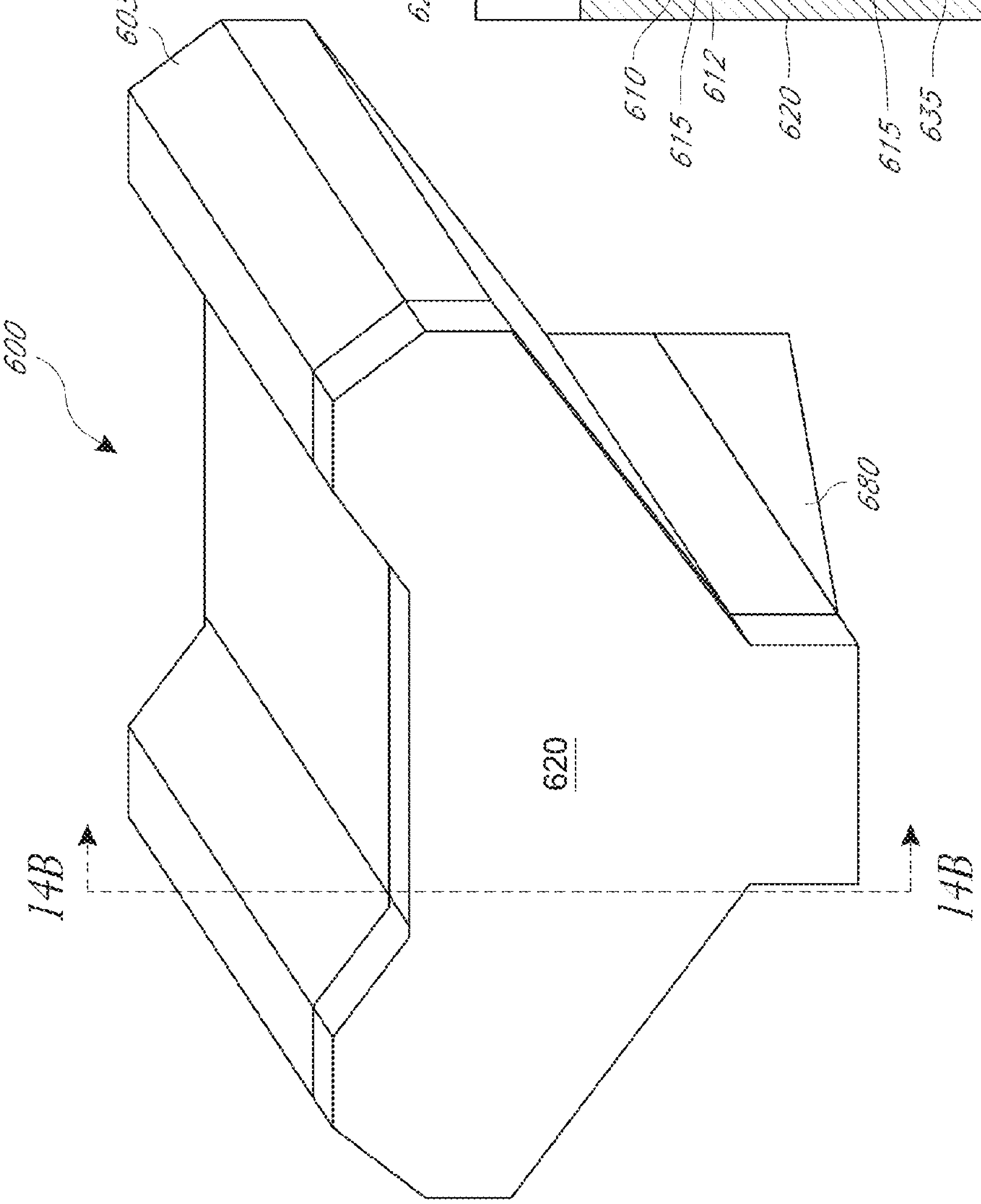


FIG. 14A

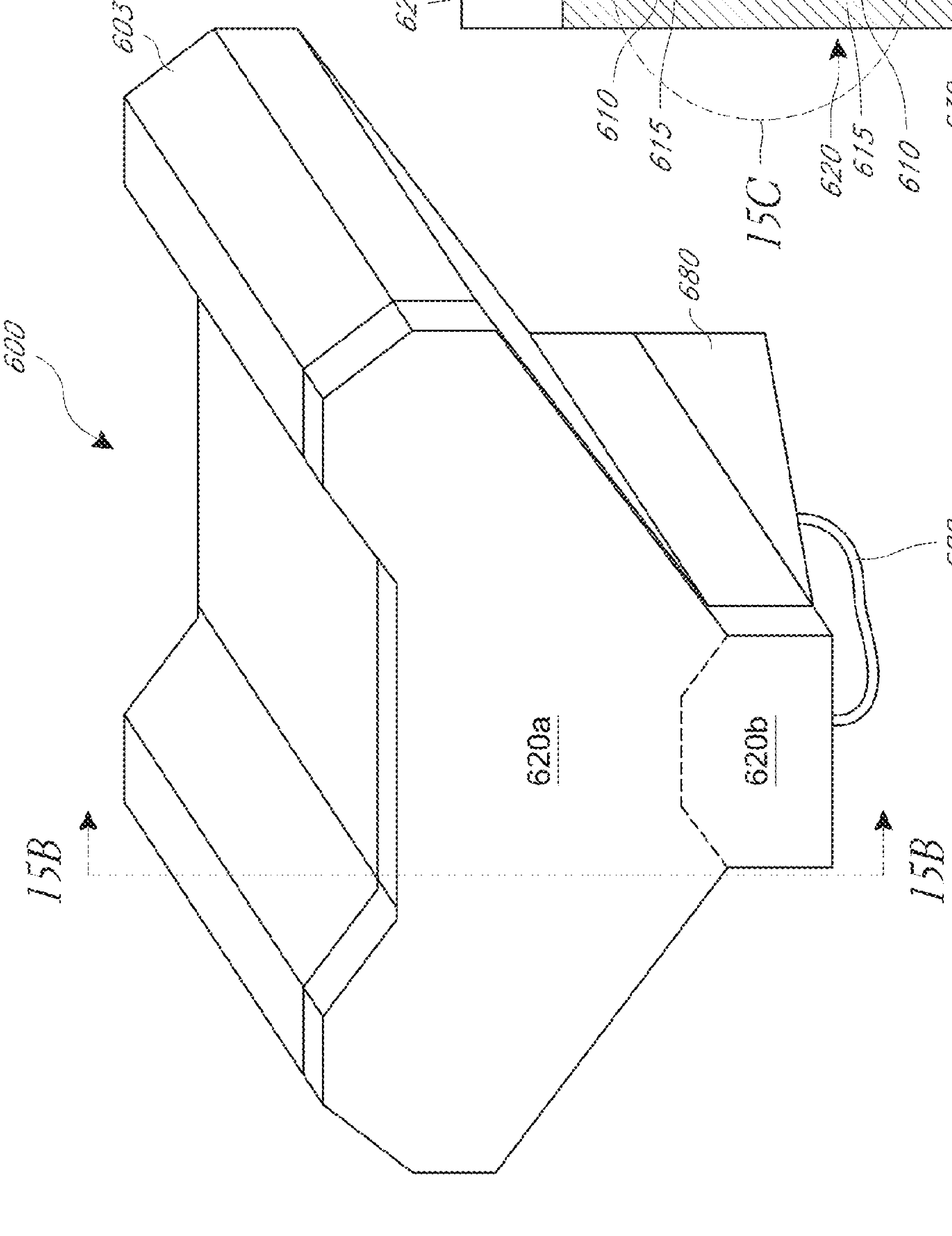


FIG. 15A

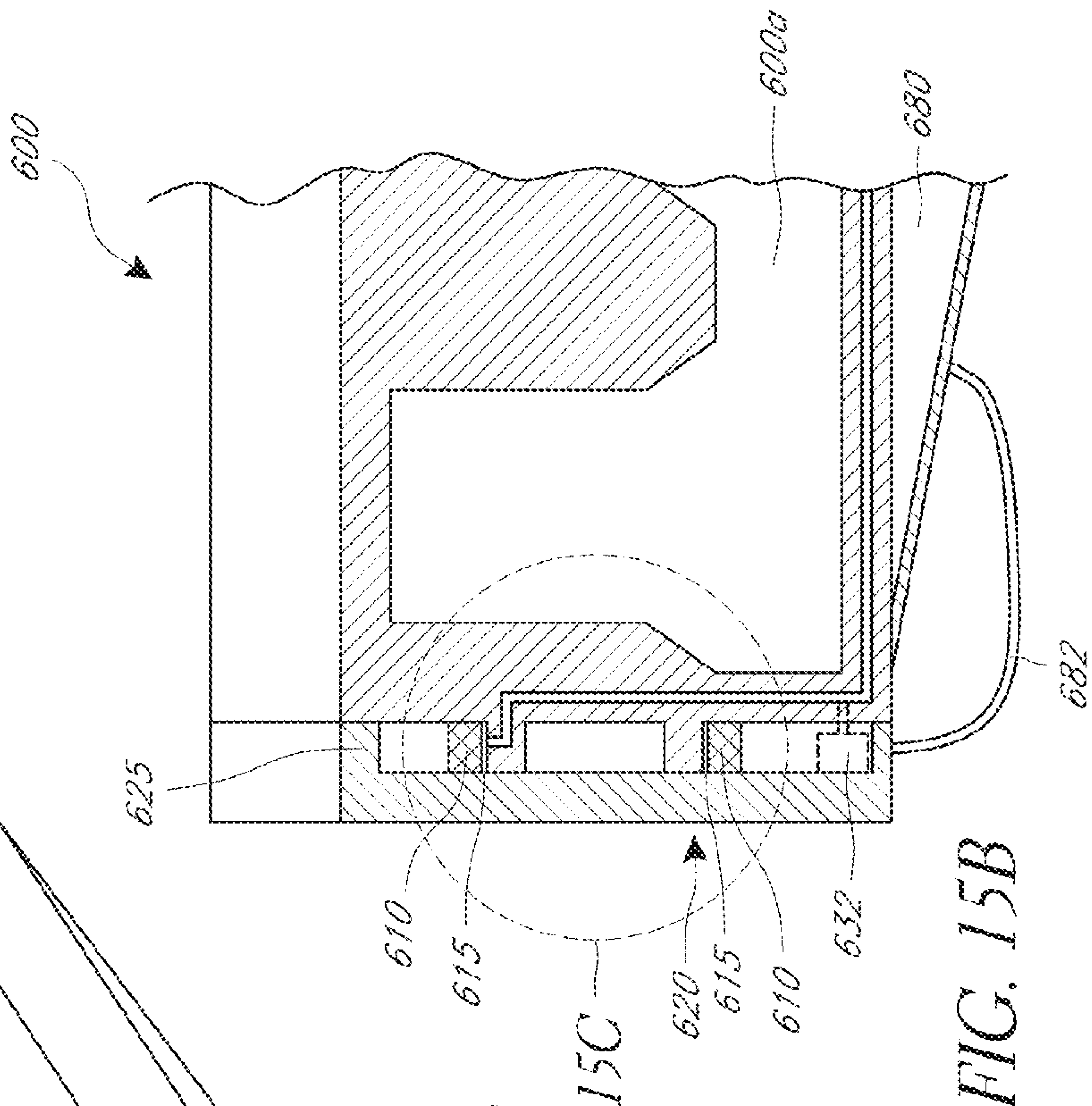
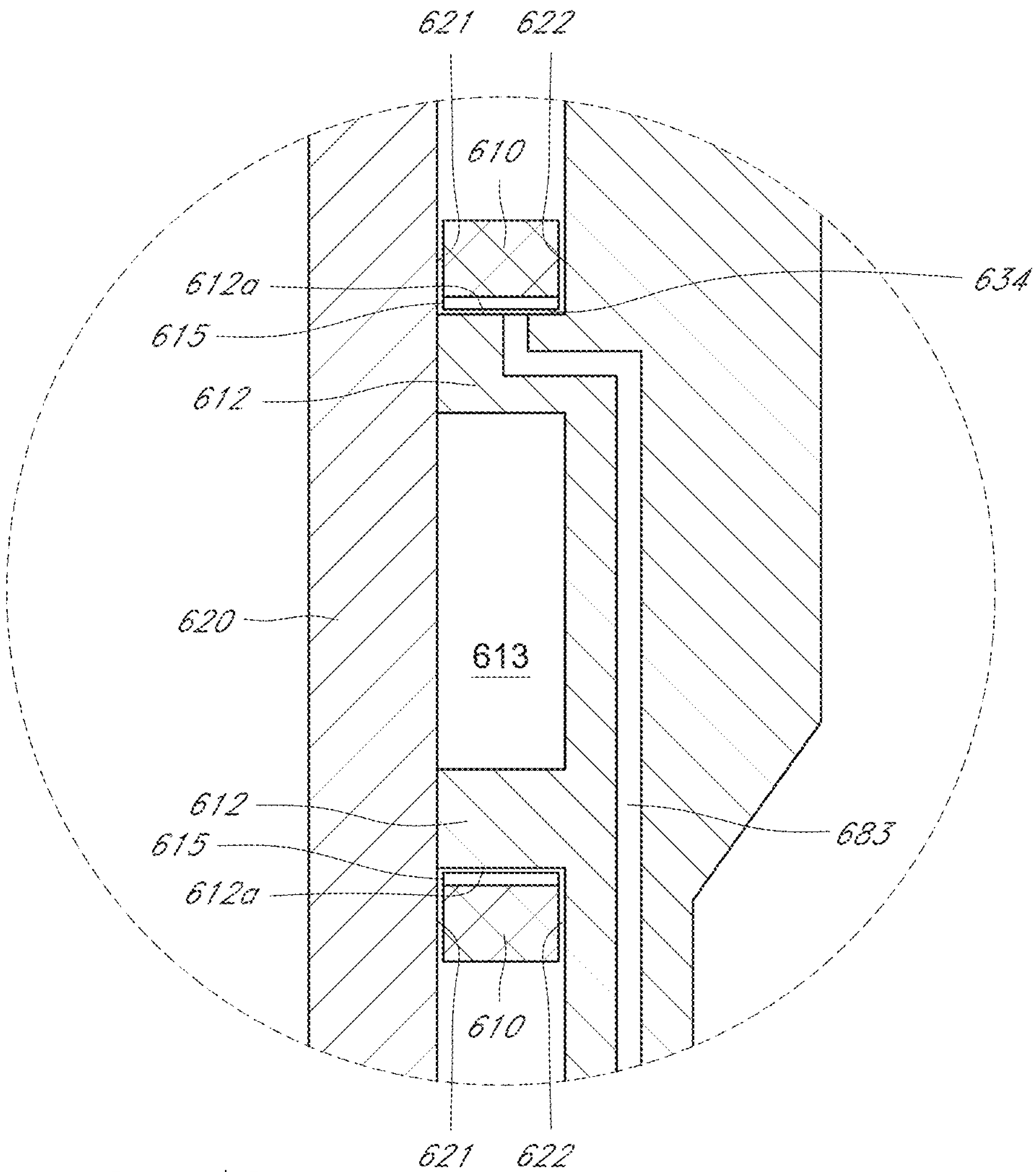


FIG. 15B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634
683

FIG. 15C

VALVETRAIN CONVERSION KIT FOR AN ENGINE

FIELD OF THE INVENTION

The present inventions disclosed herein relate to drivetrains formed of meshed gears such as those valvetrain systems used for driving camshafts in overhead valve engines.

BACKGROUND

The valvetrain system of an engine performs an important function in the operation of an engine and can affect performance of the engine. In many current commercial engines, the valvetrain system includes one or more camshafts driving one or more intake valves and one or more exhaust valves for each cylinder. Generally, in a four-stroke engine having an intake stroke, a compression stroke, a power stroke and an exhaust stroke, the intake valves open during the intake stroke and close during the compression stroke and the exhaust valves open during the exhaust stroke and close during the intake stroke. The intake valves control the ingress of combustion reactants, such as air and/or fuel, into the combustion chamber and exhaust valves control the egress of combustion products, such as H_2O, CO, CO_2, NO_x, and unburned hydrocarbons out of the combustion chamber.

The timing and movement of the intake valve and exhaust valve can play a significant role in the overall performance of an engine, such as the volumetric efficiency and maximum engine speed. Accordingly, precise synchronization of the piston and crankshaft movements with the valve and camshaft movements is of paramount importance to an engine. The camshafts are generally configured to control the timing and movement of the valves and are generally timed in accordance with movement of the pistons by means of a crankshaft coupled with the camshafts through a drivetrain. Existing drivetrains include serpentine belts, chains, and geartrains which transmit rotational energy from the crankshaft of the engine to the camshafts.

SUMMARY OF THE INVENTIONS

An aspect of at least one of the embodiments disclosed herein includes the realization that a rim gear (a gear having the hub and/or webbing removed) can be used as an idler gear of a geartrain in a valvetrain of an engine. Using a rim gear can provide the benefit of reducing weight and inertia in the geartrain and thereby increase engine efficiency. For example, lowering the inertia of a geartrain can reduce the power required to accelerate an engine improving fuel efficiency. Additionally, lower inertia can allow the engine to increase crankshaft speed (RPM) more quickly. Faster engine speed acceleration can be beneficial, for example, in racing and other applications. Thus, in some embodiments, the geartrain can include a rim gear meshed with other gears in the geartrain as an idler gear. In some embodiments, a geartrain for an internal combustion engine can include a rim gear and an idler gear shaft configured to rotatably support the rim gear.

Another aspect of at least one of the embodiments disclosed herein includes the realization that existing engine blocks, including cam-in-block engines, can be converted to an overhead cam engine using a conversion kit to for converting a push-rod engine to an overhead cam engine. In some embodiments, the kit can include at least one chamber member, at least one timing idler gear, and at least one corresponding idler gear shaft extending from the chamber member. The kit can be configured such that the chamber member mounts to the engine and provides a replacement drivetrain between at least one cam shaft and a crank shaft of the engine. The use of such a conversion kit can provide the advantage of a convenient means of converting an existing engine into an overhead cam engine using a geartrain without the need to physically embed gear shafts into the engine block or head and without the added maintenance of a belt or chain tensioner. Moreover, in some embodiments, the chamber member can be configured to provide convenient access to the geartrain for maintenance.

Another aspect of at least one of the embodiments disclosed herein includes the realization of the advantages of replacing an existing drivetrain such as a serpentine belt or timing chain with a timing geartrain. A timing geartrain can withstand much greater forces and stresses and still operate with minimal required maintenance and with a low risk of failure as compared to a belt or chain.

Another aspect of at least one of the embodiments disclosed herein includes the realization that a timing idler gear can comprise a power takeoff shaft (PTO). In some embodiments, the power takeoff shaft can be rigidly fixed to an idler gear and/or a rim gear and provide a location to power various engine components including an alternator, water pump, supercharger, air conditioner, oil pump, or power steering, etc. In some embodiments, the rim gear provides the advantage of reducing the overall weight and inertia of the power takeoff gear, but also can evenly distribute the stress from the power takeoff shaft through the rim shape. In some embodiments, the timing idler gear comprising at least one PTO can reduce the overall footprint of the engine.

Another aspect of at least one of the embodiments disclosed herein includes the realization that the chamber member can provide a plurality of locations for mounting various engine components. Often, engine components are mounted around the sides and top of an engine because there is insufficient space to mount them near the crankshaft. Often these components are powered by lengthy belts and chains that require manual or automatic tensioning and regular maintenance and replacement. As such, in some embodiments, the chamber member can provide space for engine components to be mounted directly to the chamber member, optionally, near the crankshaft, and/or use at least one power takeoff coupled with the timing idler gear. The timing geartrain also offers more precise synchronization of the valvetrain than a timing chain or serpentine belt because it does not have slack from any lack of tension as found in the belt or chain.

In some embodiments disclosed herein, a valvetrain conversion kit for an engine comprises at least one timing idler rim gear configured to be meshed with at least one of a crank gear of the engine and a cam gear of the engine. The kit further comprises a first timing gear chamber member having an interior surface and an exterior surface. The first timing gear chamber member can have a plurality of engine mounting locations corresponding to a plurality of corresponding cover mounting locations on an internal combustion engine body. The first timing gear chamber member can be configured to be rigidly attached to an engine body at the plurality of mounting locations. The first timing gear chamber member can further comprise a timing idler rim gear shaft supported by the interior surface, the timing idler rim gear shaft having an exterior shaft surface where the exterior shaft surface is configured to rotatably support the timing idler rim gear. Optionally, an oil passageway extends at least partially through a boss on the timing idler rim gear shaft to the exterior shaft surface and is configured to guide a lubricant to a lubricant space between the exterior shaft surface and a rotational surface of the timing idler rim gear when the at least one timing idler rim gear is positioned about the exterior shaft surface.

In some embodiments disclosed herein, the valvetrain conversion kit comprises a second timing gear chamber member configured to engage the first timing gear chamber member to define an enclosed timing gear chamber about the at least one timing idler gear and the timing idler rim gear shaft. Optionally, the first timing gear chamber member faces towards the engine when assembled with the internal combustion engine or the first timing gear chamber member faces away from the engine when assembled with the internal combustion engine.

In some embodiments disclosed herein, an internal combustion engine comprises an engine block, the engine block including an engine body supporting a crank shaft, an overhead valve camshaft, and a timing geartrain disposed on a first side of the engine body and configured to transmit torque from the crankshaft to the overhead valve camshaft. The timing geartrain can include a crank gear coupled with the crankshaft, a cam gear coupled with the overhead valve camshaft, and an idler rim gear meshed with at least one of the crank gear and the cam gear. An idler rim gear shaft can be disposed on the first side of the engine body and rotatably support the idler rim gear.

All of these embodiments are intended to be within the scope of at least one of the inventions disclosed herein. These and other embodiments of the inventions will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached Figures, the inventions not being limited to any particular preferred embodiment disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is perspective view of a conventional push-rod type engine comprising a valvetrain.

FIG. **2** is a top view of a pair of conventional timing gears.

FIG. **3** is a schematic illustration of a conventional overhead valve type engine using a serpentine timing chain as a valvetrain.

FIG. **4** is a photograph of an overhead valve type engine using conventional idler gears in a valvetrain.

FIG. **5** is a cross-sectional view showing a conventional idler gear with a reinforced section of the engine housing wall.

FIG. **6**A is a schematic, exploded illustration of parts of an embodiment of a kit for replacing a conventional drivetrain of an engine including a chamber member and two idler gear shafts configured to support two timing idler gears.

FIG. **6**B is a side view of the chamber member of the kit of FIG. **6**A.

FIG. **6**C is a sectional view taken along the line **6**C in FIG. **6**A.

FIG. **6**D is a side view of the chamber member of the kit illustrating a partially assembled kit.

FIG. **6**E is a schematic, top view of a timing idler gear comprising a rim gear.

FIG. **7**A is a schematic, perspective view of an assembled kit.

FIG. **7**B is a detailed view of FIG. **7**C.

FIG. **7**C is a sectional view taken along the line **7**C in FIG. **7**A.

FIG. **8**A is a schematic, perspective view of another embodiment of a partially assembled kit.

FIG. **8**B is a sectional view taken along the line **8**B in FIG. **8**A.

FIG. **8**C is a detailed view of FIG. **8**B.

FIG. **9**A is a schematic illustration of a second chamber member in an embodiment of a kit for replacing a conventional valvetrain in an existing engine using at least one timing idler gear.

FIG. **9**B is a front view of the kit of FIG. **9**A showing a partially assembled kit.

FIG. **9**C is a detailed view of FIG. **9**B.

FIG. **9**D is a schematic, perspective view of another embodiment of a partially assembled kit.

FIG. **9**E is a sectional view taken along the line **9**E in FIG. **9**D.

FIG. **9**F is a detailed section view taken along the line **9**F is FIG. **9**D.

FIG. **9**G is a detailed view of FIG. **9**E.

FIG. **10** is a sectional view of an embodiment of a power takeoff shaft compatible with each of the embodiments shown and described herein.

FIG. **11** is a sectional view of an embodiment of an timing idler gear compatible with each of the embodiments shown and described herein.

FIG. **12**A is a schematic illustration an embodiment of an engine comprising timing idler gear shafts.

FIG. **12**B is a sectional view taken along the line **12**B in FIG. **12**A.

FIG. **13**A is a schematic illustration of the engine in a partially assembled state.

FIG. **13**B is a sectional view taken along the line **13**B in FIG. **13**A.

FIG. **14**A is a schematic illustration of the engine in a partially assembled state.

FIG. **14**B is a sectional view taken along the line **14**B in FIG. **14**A.

FIG. **15**A is a schematic, perspective view of the engine comprising timing idler gear shafts in an assembled state.

FIG. **15**B is a sectional view taken along the line **15**B in FIG. **15**A.

FIG. **15**C is a detail view of FIG. **15**B.

DETAILED DESCRIPTION

The following detailed description is merely illustrative in nature and is not intended to limit the embodiments of the subject matter or the application and uses of such embodiments. Any implementation described herein as exemplary is not necessarily to be construed as preferred or advantageous over other implementations. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the proceeding technical field, background, brief summary, or the following detailed description.

Certain terminology can be used in the following description for the purpose of reference only, and thus are not intended to be limiting. For example, terms such as "upper", "lower", "above", and "below" refer to directions in the drawings to which reference is made. Terms such as "front", "back", "rear", "left side," and "right side" describe the orientation and/or location of portions of the component within a consistent but arbitrary frame of reference which is made clear by reference to the text and the associated drawings describing the component under discussion. Such terminology can include the words specifically mentioned above, derivatives thereof, and words of similar import. Similarly, the terms "first", "second", and other such numerical terms referring to structures do not imply a sequence or order unless clearly indicated by the context.

Conventional Valvetrains

With reference to FIGS. **1-4**, a conventional valvetrain performs the function of transmitting torque from a crankshaft to a camshaft and providing proper timing between the crankshaft and the valve system in an internal combustion engine. However, prior art valvetrains have numerous disadvantages that are addressed by embodiments of the present inventions. While certain disadvantages of the prior art devices of FIGS. **1-4** are described below, such description is illustrative of some of the known disadvantages, but is not exhaustive.

FIG. **1** illustrates a prior art Chevrolet LS engine **10**. The engine **10** includes a block **1** and cylinder heads **2** for each bank of cylinders. For purposes of clarity, other components of the engine **10**, such as the intake manifold and the exhaust manifold, have been omitted. The valvetrain of the engine **10** includes a single camshaft (not shown) positioned within the block **1** at a location below the deck of the cylinder heads **2**. The valvetrain also includes multiple overhead valves **15** positioned within the cylinder head **2** with a single intake valve and a single exhaust valve per cylinder of the engine **10**. In order to actuate the valves **15** via the camshaft, the valvetrain includes a series of lifters (not shown), pushrods **20**, and rocker arms **25** operably coupling the camshaft to the valves **15**. This series of valvetrain components run from the block **1** to the cylinder heads **2** and thus present a significant amount of mass of the valvetrain system.

As shown along a front side of the engine **10**, the single camshaft is driven by the crankshaft via a chain **3** coupled to a crank gear (not shown) attached to the crankshaft and a cam gear **5** attached to the camshaft, which is positioned within the block **1**. The front side of the engine also includes a plurality of fastener holes **50** designed to receive and engage fasteners for attachment of various components, such as a cover (not shown), over the chain **3** and gear **5**, as well as accessories such as an alternator (not shown), power steering pump (not shown), air conditioner compressor (not shown) and the like. Generally, the fastener holes **50** are designed to engage threads of a screw, bolt, stud or the like.

FIG. **2** is a top view of a conventional timing gear set such as those shown in FIG. **1**. The timing gear set includes a crank gear **9** configured to be mounted on a crankshaft and a conventional timing gear **5**. The timing gear **5** comprises a hub **8** configured to be mounted on a shaft, a rim **23** on which a plurality of gear teeth **25** are mounted, and a webbing **21** configured to connect the hub **8** to the rim **23**. One of the disadvantages of timing gear **5** is the additional weight and inertia from the hub **8** and webbing **21**.

In some embodiments of the present disclosure described below, one object is to provide a timing idler gear comprising a "rim gear"; a gear without a hub **8** connected to the gear teeth with webbing **21**. Optionally, a rim gear is provided without some or all of the webbing to reduce weight and inertia. While the benefit of increased engine efficiency can be marginal for each individual gear, the reduced weight and inertia across an entire valvetrain comprising a plurality of gears can be a significant factor in increased efficiency.

FIG. **3** is an illustration of a conventional overhead cam type engine using a serpentine timing chain or belt **103** to transfer torque from the crankshaft **107** to the camshaft **104**. The engine includes an engine body **100** comprising a head **103**, an engine block **101**, and an engine housing wall **102**. Affixed to engine housing **102** are a plurality of idler gear shafts **112**. Idler gears **110** are rotatably mounted to the idler gear shafts **112**.

Additional elements not shown include a tensioning mechanism to ensure that the lengthy timing chain **103** maintains sufficient tension to remain on the geartrain. Serpentine chains and belts take up a substantial amount of space particularly on the face of an engine. There can be insufficient space on the face of the engine for mounting other engine-powered accessories to the engine. These accessories can be displaced to the sides of the engine and/or to locations off of the engine in a less than optimal use of space.

FIG. **4** is a photograph of a prior art timing system for driving overhead cams from the crankshaft of an engine. The engine shown in FIG. **4** is a Ford 427 SOHC V8, known as the "Cammer," and modified to use a timing geartrain with a plurality of meshed gears for driving overhead camshafts. As shown in FIG. **4**, each of the idler gears in the timing geartrain includes both a hub and a webbing.

FIG. **5** is a section view showing an idler gear **110** with a reinforced section **27** required to mount an idler gear shaft to engine housing wall **102**. Idler gear **110** is fixedly attached to idler shaft **112**. The idler shaft **112** is rotatably mounted to engine housing wall **102**. However, in order to support the weight and force placed on the idler shaft **112**, the engine housing wall is reinforced such as in the manner shown in FIG. **5**. Reinforced section **27** enables the engine housing wall **12** to support this additional force. One aspect of some embodiments of the present disclosure includes the realization that a idler shaft need not be directly mounted to the engine housing wall and instead can be mounted to a chamber member.

Conversion Kit for Replacing an Existing Valvetrain

FIG. **6**A illustrates an embodiment of a conversion kit providing a replacement valvetrain for synchronizing the rotational movement of an overhead cam camshaft **204** with the crankshaft **207** using a timing idler gear shaft **212** coupled to a chamber member **220**. As illustrated in FIG. **6**A, an engine **200** comprises an engine block **201**, at least one cylinder head **203**, and an engine housing wall **202**. The engine **200** can be designed as a cam-in-block engine that is converted into an overhead cam engine using the conversion kit. In some embodiments, engine **200** has been retrofitted with an overhead cam head **203** and valve cover **203**A.

An overhead camshaft **204** is supported by the head **203** and extends outwardly therefrom. A cam gear **205** is mounted to the end of the camshaft **204**. The camshaft **204** can be rotatably seated in the head **203** and configured to control the engine valve timing system in accordance with principles of operation of overhead cam valve systems which are well-known in the art. In some embodiments, the camshaft **204** extends through engine housing wall **202** to an exterior side of the engine **200**.

The engine **200** additionally comprises a crankshaft **207** coupled with a crank gear **209**. In some embodiments the crank gear **209** is fixedly coupled to the crankshaft **207**. Optionally, the crank gear and the crankshaft extend from the housing wall **202** of engine **200**. Crankshaft **207** operates to convert the linear motion of pistons within the engine into rotational energy as is well known in the art.

In some embodiments of the conversion kit, the chamber member **220** can comprise a bracket for spacing the chamber member **220** a predetermined distance from the engine housing **202**. Optionally, the bracket comprises a peripheral wall **225**. Optionally, peripheral wall **225** extends all around the perimeter of the chamber member **220**. Optionally, the peripheral walls **225** extends away from an interior surface **223** of the chamber member **220**. Optionally, the peripheral wall **225** is configured to conform to the contours of the engine housing walls **202**. Optionally, when in the fully assembled state, the chamber member **220** is mounted to engine **200** to create a chamber **235** that encompasses the timing idler gear. Optionally, the profile of the chamber member **220** is configured to match or substantially match the profile of the engine housing wall **202**. Optionally, the chamber member **220** is configured to overlay the timing geartrain and or to create a chamber encapsulating the timing idler gear between the engine housing wall **202** and the chamber member **220**.

In some embodiments, the chamber member **220** comprises a top portion **220***a* and a bottom portion **220***b*. Optionally, the bottom portion **220***b* is configured to comprise an oil reservoir **280** as discussed below in reference to FIG. **7**A. Optionally, both portions **220***a, b* are configured to be assembled with the engine **200**. Optionally, the bottom portion **220***b* is configured to remain assembled with the engine **200** when the top portion **220***a* is removed from the engine **200** and thereby the oil reservoir **280** can remain in place while an operator obtains access to the geartrain by removing the top portion **220***a*.

In some embodiments of the conversion kit, the chamber member **220** can comprise an interior surface **223**. Optionally, the interior surface **223** is substantially flat or in other embodiments it is curved or comprises contours. Optionally, the timing idler gear shaft **212** can extend from the interior surface **223**. In some instances, this specification refers to a single timing idler gear, but such descriptions are intended to apply to embodiments including other numbers of idler gears, such as embodiments including multiple timing idler gears meshed with one of the crank gear **209**, the cam gear **205** or another of the timing idler gears.

In some embodiments, the timing idler gear shaft **212** is formed integrally with the interior surface **223** to form a monolithic construction of the chamber member **220**. Optionally, the monolithic construction can be cast, wrought, forged, hogged-out or machined. Optionally, the monolithic construction can be case of an aluminum alloy. Optionally, the idler gear shaft **212** can be mechanically fastened to interior surface **223** by at least one mechanical fastener including but not limited to screws and bolts. In other embodiments, timing idler shaft **212** can be welded or otherwise affixed to interior surface **223**. In some embodiments the idler gear shaft **212** can comprise an interior space **213**. In other embodiments idler gear shaft **212** can comprise a solid material where the interior space **213** would otherwise be. In some embodiments of the conversion kit the idler shaft **212** further comprises a boss **231**, as described further in reference to FIG. **8**C.

FIG. **6**B illustrates a side view of the chamber member **220** and the peripheral wall **225**. FIG. **6**C illustrates a cross-sectional view of chamber member **220** taken along the line **6**C in FIG. **6**A. In some embodiments chamber member **220** comprises an idler gear shaft **212** extending from interior surface **223**. Optionally, the idler shaft **212** comprises an exterior surface **212***a* on which the timing idler gear **210** is configured to be rotatably coupled.

FIG. **6**C shows a step in assembling the conversion kit comprising the chamber member **220** and the timing idler gear **210** with the engine **200**. In some embodiments the idler gear **210** is configured to be rotatably mounted to the idler shaft **212**. Optionally, the timing idler gear **210** is configured to be meshed with at least one of the crank gear **209** or the cam gear **205**. In some embodiments of the conversion kit, the conversion kit comprises more than one timing idler gear **210** and a complete timing idler geartrain extending between the crank gear **209** and the cam gear **205**.

Optionally, chamber member **220** comprises a pry slot located proximate the idler gear shaft and configured to aid in the removal of the timing idler gear from the idler shaft.

FIG. **6**D shows an embodiment of the timing idler gear **210** comprising a rim gear. The timing idler gear **210** as described herein can be used with any of the embodiments as described in the present disclosure including the embodiments shown in previous and subsequent figures. Furthermore, each of the applications of the timing idler gear **210** described herein can comprise a rim gear. Additionally, the timing idler gear **210** can comprise any type of gear tooth style including spur gear, beveled gear, herringbone gear, etc.

In some embodiments, the rim gear comprises a rim **211** and a plurality of teeth **224**. Optionally, the rim gear is a gear without a hub and/or without both a hub and a webbing. In some embodiments the rim gear comprises an inside diameter **10***a* and an outside diameter **10***b*. Optionally, the inside diameter **10***a* is equal to or greater than approximately 50% of the outside diameter **10***b*. Still in other embodiments the inside diameter **10***a* is equal to or greater than approximately 75% of the outside diameter **10***b*. In still other embodiments the inside diameter **10***a* is equal to or greater than 90% of the outside diameter **10***b*. In still other embodiments the inside diameter **10***a* is between approximately 75% and 90% of the outside diameter **10***b*. As used herein, the term "rim gear" is intended to mean a gear without a webbing connecting the teeth to a hub and/or with an inside diameter is equal to or greater than approximately 50% of the outside diameter.

Additionally, for the purposes of this specification approximately means within five percentage points of whatever units are being measured. In some embodiments, the rim gear interior diameter **10***a* ranges between approximately 40% and 95% of the outside diameter **10***b*. In some embodiments, the rim gear interior diameter **10***a* ranges between approximately 50% and 90% of the outside diameter **10***b*. In other embodiments it ranges between 60% and 90% of outside diameter **10***b*. In other embodiments interior diameter **10***a* ranges between 70% and 85% of exterior diameter **10***b*. In other embodiments of either the rim gear **210**, interior diameter ranges between 80% and 90% of the outside diameter **10***b*. In some embodiments, the inside diameter **10***a* is approximately 80% of the outside diameter **10***b*. In other embodiments, the inside diameter **10***a* is approximately 95% of the outside diameter **10***b*. In other embodiments, the inside diameter **10***a* is approximately 90% of the outside diameter **10***b*. In some embodiments, the inside diameter **10***a* is approximately 75% of the outside diameter **10***b*. In some embodiments, the inside diameter **10***a* is approximately 60% of the outside diameter **10***b*. In some embodiments, the inside diameter **10***a* is approximately 50% of the outside diameter **10***b*. In some embodiments, the inside diameter **10***a* is approximately 40% of the outside diameter **10***b*

Referring now to FIG. **7**A, FIG. **7**A is a view of the conversion kit as shown in FIGS. **6**A-**6**D in an assembled state.

In FIG. **7**A, the engine chamber member **220** is fastened to engine housing wall **202** at a plurality of mounting locations (not shown) with the timing idler gear **210** rotatably coupled to the shaft **212** and meshed with one of the crank gear **209** or the cam gear **205**. In some embodiments the chamber member **220** is mounted to the engine housing **202** with the idler shaft **212** extending from the interior surface **223** towards the housing wall **202**. As discussed below with reference to FIG. **9**, the idler shaft **212** can be mounted extending away from the housing wall **202** in some embodiments of the current disclosure.

Chamber member **220** optionally comprises a plurality of mounting locations around a perimeter of the chamber member **220** that correspond to a plurality of mounting locations on the engine housing walls **202**. Optionally, at least some of the plurality of mounting locations are on a central portion of the chamber member **220**.

In some embodiments, the engine **200** can also comprise the oil reservoir **280** containing an oil pump (not shown). Optionally, the oil reservoir **280** can be the oil reservoir used for collecting lubrication oil circulated to various components within the engine **200** with a lubrication system (not shown). For example, the oil pump draws oil from the reservoir **280** and pumps the collected lubricant to various oil galleries, bearings and other sliding components, such as cylinder walls, crankshaft bearings, camshaft beatings, valve stems, etc.

FIG. **7**C is a sectional view of the assembly as shown in FIG. **7**A taken along the line **7**C. This sectional view shows the assembled conversion kit comprising the chamber member **220** fastened to the engine **200** and including idler gear **210** rotatably mounted on the outside surface **212***a* of the idler shaft **212**. The engine **200** comprises an engine interior space **200***a* as represented in schematic form in FIG. **7**C. The interior space **200***a* can be a lower portion of the engine block **201** or crankcase of the engine **200**, to which lubrication oil returns after being pumped to various components within the engine **200**.

In some embodiments, the chamber member **220** is configured to define a chamber **235** when it is placed against the housing wall **202** of the engine **200**. Optionally, the chamber **235** encompasses the entire timing geartrain. Optionally, chamber **235** encompasses the timing idler gear **210** and the timing idler shaft **212**. Optionally, the chamber **235** is created between the interior surface **223**, the engine housing wall **202**, and the peripheral wall **225**. The peripheral wall **225** can be configured to abut against a front side such as the housing wall **202** of the engine **200**, so as to maintain the chamber member **220** at a predetermined spacing away from the front surface and thus define an enclosed or partially enclosed chamber around the timing geartrain. Optionally, the peripheral wall is configured to match the contours of the front of the engine **200**. In some embodiments, the peripheral wall is uneven to match an uneven engine front. In other embodiments, the peripheral wall is even to match an even or uniform engine front.

In some embodiments the conversion kit further comprises an oil gasket. Optionally, the oil gasket is configured to be placed between the chamber member **220** in the engine housing wall **202**. Optionally, the oil gasket is configured to be mounted between the peripheral wall **225** and the engine housing wall **202**. The oil gasket functions to create an oil seal about the chamber **235**. This has the advantage of creating a self-enclosed lubrication chamber. In some embodiments, the chamber **235** comprises an oil reservoir **235***a* in a lower portion of the chamber **235**.

FIG. **7**B, is a detail view of FIG. **7**C. According to some embodiments of the conversion kit, chamber member **220** and idler shaft **212** can be aligned with engine **200** by at least one mounting tab **216** included in the kit. Mounting tab **216** can constitute a projection from engine housing **200** and functions to align chamber member **220** with engine **200** during assembly of the kit. Optionally, a honed surface **221** can be included on the interior surface **223** near idler shaft **212** to reduce friction between timing idler gear **210** and interior surface **223**. Optionally, honed surface **222** can be included on engine housing **202** to reduce friction between idler gear **210** and engine housing **202**.

In some embodiments of the conversion kit, a bearing **215**, such as a needle or ball bearing is mounted to the exterior surface **212***a* of the idler shaft **212** to reduce friction between idler shaft **212** and idler gear **210**. In other embodiments, the bearing **215** can be a plain, sleeve, or hydrodynamic bearing. Optionally, exterior surface **212***a* is honed to reduce friction between idler gear **210** and idler shaft **212**. In the form of plain or sleeve bearings, the bearing **215** can have a polished surface corresponding to the outer surface **212***a* of the idler shaft **212**, optionally lubricated with grease or oil. In some embodiments, oil for the bearing **215** is supplied continuously during operation so that the idler gear **210** rotates on a thin oil film, optionally, under the principle of operation of a hydrodynamic bearing.

Referring now to FIGS. **8**A and **8**B, FIG. **8**A is an embodiment of an assembly view of the conversion kit for converting an internal combustion engine to an overhead cam engine using a timing idler gear and including components of a lubrication system. In some embodiments, the conversion kit comprises an oil supply line **283** extending between the oil reservoir **280** and the chamber member **220**. Optionally, the oil supply line **283** comprises an exterior portion **283***a* fluidly coupled with the oil reservoir **280** and an interior portion **283***b* fluidly coupled with the exterior surface **212***a* of the idler shaft **212**. Optionally, the exterior portion **28***a* can be fluidly coupled with the oil pump contained in the oil reservoir **280**, for example, with oil supply line **283**.

In some embodiments of the conversion kit, an oil supply return line **282** can be fluidly coupled at a first end with the chamber oil reservoir **235***a*. Optionally, a second end of the return line **282** can be fluidly coupled with the reservoir **280** and function to return the supply of oil pumped into the chamber **235** by the oil supply line **283**. Optionally, the return line **282** is coupled at the bottom of the chamber **235** at a drain **281**. In some embodiments, the return line **282** may comprise an exterior portion and/or an interior portion through the engine **200** or the chamber member **220**.

With reference to FIG. **8**C, in some embodiments, the oil supply line **283** is fluidly coupled with a lubrication space **234** located between the idler gear **210** and the exterior surface **212***a* of the idler shaft **212**. In some preferred embodiments, the oil supply line **283** is configured to deliver a supply of oil to lubricate the idler gear **210**. Optionally, the chamber member **220** can be configured to allow the oil supplied to the lubrication space **234** to drip from the lubrication space **234** and collect in the oil reservoir **235***a*. Optionally, the oil supply returns to the oil reservoir **280** through the drain **281** and the return line **282**. The oil supply can thus be recirculated through the oil supply line **283**.

In a preferred embodiment, the interior portion **283***b* of the oil supply line extends through a wall portion of the chamber member **220**. Optionally, interior oil line **283***b* is created by gun drilling through wall portions of the chamber member **220** and plugging unnecessary exterior holes left in the wall portions. As illustrated in FIG. **8**C, the interior portion **283***b* can comprise an extension line **233** fluidly coupled with the exterior surface **212***a* through the boss **231**. Optionally, the boss **231** can be created as an original part of the idler shaft **212** as illustrated in FIG. **6**A. The extension **233** can be created by drilling through the boss **231** and idler shaft **212** and plugging any exterior holes created by the drilling process. In other embodiments, interior oil line **283***b* extends directly through the idler shaft **212***a* to the exterior surface **212***a* without the boss.

In some embodiments of the conversion kit, the lubrication system is self-enclosed (as described in greater detail below in reference to FIG. **9**E) wherein the oil supply is recirculated independent of the lubrication system of the engine **200**. Optionally, the conversion kit comprises an oil pump **232** that pumps oil from within the chamber **235** through the oil supply line **283** and up to the lubrication space **234**. Optionally, the oil pump is located in the chamber **235**. Optionally, the oil pump is located exterior to the chamber **235**. Optionally, the oil supply line **283** is fluidly coupled with the oil reservoir **235***a*. In such a configuration, the oil return line **282** can be omitted from the conversion kit. Optionally, the oil reservoir is located exterior to the chamber **235**. Optionally, the oil pump is configured to pump the oil supply through the interior portion **283***b*. Optionally, the interior portion **283***b* comprises the extension **233** and/or the boss **231** as described above. Thus, the oil supply line **283** can deliver a supply of oil to the lubrication space **234** without utilizing the oil supply of the engine **200**.

FIGS. **9**A-**9**G illustrate another embodiment of a conversion kit comprising a first chamber member **321** that includes at least one idler shaft **312** extending from an interior surface **323** (FIG. **9**B). Each of the features and constructions of the first embodiment as described in FIGS. **6**-**8** can also be incorporated in this second embodiment as shown in FIGS. **9**A-**9**G. In some embodiments, the first chamber member **321** is configured to be mounted to an engine housing **302** of an engine **300** with the idler gear shaft **312** extending away from the engine **300** (FIG. **9**D). A second chamber member **320** (FIG. **9**A) is optionally used as a cover to create a chamber **335** between the first chamber member **321** and the second chamber member **320**.

With continued reference to FIG. **9**A, the second chamber member **320** is optionally configured to be mounted to the first chamber member **321** at a plurality of cover mounting locations **351**. Optionally, the cover mounting locations **351** are on a perimeter of the second chamber member **320**. Optionally, the cover mounting locations **351** comprise at least one central mounting location. Optionally, the second chamber member **320** comprises a flat plate or a contoured plate. Optionally, the second chamber member **320** comprises a top half **320***a* and a bottom portion **320***b* wherein the top portion **320***a* and the bottom portion **320***b* are separable and independently mountable to the first chamber member **321**. Optionally, the bottom portion **320***b* is configured to be left in place when the top portion **320***a* is removed from the engine **300**. In those embodiments where the chamber **335** comprises an oil supply, the bottom portion **320***b* can retain the oil supply within the chamber even when the top portion **320***a* is removed, for purposes such as maintenance of the geartrain.

The second chamber member **320** can further comprise at least one passageway **360** from an interior surface **323***a* to an exterior surface **232***b* of the second chamber member **320**. Each of the passageways **360** can be placed at a location on the second chamber member **320** to align with a power take off shaft **366** when assembled with the first chamber member **321**. The power take off shaft **366** is further described below in relation to FIGS. **9**E, **9**G, and **10**. In some embodiments, the passageway **360** is configured such that the power takeoff shaft **366** extends through the second chamber member.

FIG. **9**B depicts an elevational view of an embodiment of the conversion kit showing the first chamber member **321** having idler gears **310** configured to be meshed with a crank gear **309**, a crankshaft **307**, and with other idler gears **310** to form a geartrain for transferring torque from the crankshaft **307** to the camshaft **304**, with the second chamber member **320** removed.

In some embodiments the first chamber member **321** comprises a plurality of engine mounting locations **350** that are configured to mount the first chamber member to the engine **300** with the idler shafts **312** extending away from the engine. Optionally, the engine mounting locations **350** can be spaced around the perimeter of the second chamber member **320**. In some embodiments, the cover mounting locations **351** can also correspond to the engine mounting locations **350**. In a preferred embodiment, at least some of the engine mounting locations **350** are separate from at least some of the cover mounting locations **351** such that the first chamber member **321** can be assembled with the engine **300** before the second chamber member **320** is assembled with the first chamber member **321**.

In some embodiments, idler shafts **312** of the first chamber member include at least one interior mounting shaft **340**. Optionally, the interior mounting shaft **340** acts as the central mounting location **351** for the second chamber member **320** to attach to the first chamber member **321**. Optionally, the interior mounting shaft **340** comprises a standalone shaft extending from the interior surface **323** of the first chamber member **321**. Alternatively the interior **313** of the idler shaft **312** is a solid volume and the interior mounting shaft **340** comprises a hole within the solid volume.

In some embodiments first chamber member **321** comprises a peripheral wall **325**. Optionally, the peripheral wall **325** extends all the way around a perimeter of the first chamber member **321**. Optionally, the peripheral wall **325** is configured to comprise the mounting locations **350**. In some embodiments, the second chamber member **320** comprises the peripheral wall **325**. In some embodiments, the peripheral wall **325** is split between the first and the second chamber members **321**, **320**.

As noted above, in some embodiments the first and second chamber member **321** and **320** are configured to create an interior chamber **335**. Optionally, the conversion kit includes a gasket that can be placed between the first chamber member and the second chamber member **320** such that the chamber **335** can comprise an oil reservoir **335***a*. Optionally, oil reservoir **335***a* can comprise a lower portion of the chamber **335** specifically configured to collect oil. Optionally, the oil reservoir is exterior to the chamber **335** and is fluidly connected to the chamber **335**.

In some embodiments of the conversion kit, the first chamber member **321** further comprises at least one access hole corresponding to one of the camshaft **305** and the crankshaft **307**. The access holes **371** can provide the crank and cam gears **305**, **309** access within the chamber **335**. Optionally, at least one of the cam gear **305** or the crank gear **309** is removed from the shafts **304**, **307** during the assembly of the conversion kit with the engine **300** such that the first chamber member **321** can be mounted to the engine **300**. Optionally, the first and second chamber members **321**, **320** are configured such that the cam gear **305** and the crank gear **309** are entirely enclosed within the chamber **335** when assembled together. Optionally, the first chamber member **321** comprises at least two separate portions **321***a*, **321***b* that can be assembled around the camshaft **305** and/or the crankshaft **307**. One possible division of the first chamber member **321** is as indicated by the dashed lines in FIG. **9**B.

FIG. **9**C depicts a detail of FIG. **9**B in the assembled state. In some embodiments of the conversion kit, a bearing **315**, such as a needle or ball bearing is mounted to the exterior surface **312***a* of the idler shaft **312** to reduce friction between idler shaft **312** and idler gear **310**. In other embodiments, the bearing **315** can be a plain, sleeve, or hydrodynamic bearing. Optionally, exterior surface **312***a* is honed to reduce friction between idler gear **310** and idler shaft **312**. In the form of plain or sleeve bearings, the bearing **315** can have a polished surface corresponding to the outer surface **312***a* of the idler shaft **312**, optionally lubricated with grease or oil. In some embodiments, oil for the bearing **315** is supplied continuously during operation so that the idler gear **310** rotates on a thin oil film, optionally, under the principle of operation of a hydrodynamic bearing.

In some embodiments idler gear shaft **312** further comprises a boss **331**. The boss **331** can optionally comprise an extension **333** to an oil supply line **383** as described below.

FIG. **9**D depicts an assembly view showing the first chamber member **321** mounted onto the engine **300** at the plurality of engine mounting locations **350** and the second chamber member **320** mounted at the plurality of cover mounting location **351** to the first chamber member **321** by a plurality of mechanical fasteners **352**. Optionally, first chamber members **321** can be directly mounted to engine **300** at an engine housing **302** of the engine **300**. The shafts **310** are optionally pointed away from engine **300**. Optionally, the second chamber member **320** acts as a cover to create chamber **325**. Such a configuration allows for easy and convenient access to the geartrain of the conversion kit by removing the second chamber member **320**. Optionally, only the top portion **320***b* of the second chamber member **320** need be removed to provide access to the idler gear **310**. In such a configuration, the oil reservoir **335***a* formed by bottom portion **320***a* can be optionally maintained with an oil supply contained within it when the top portion **320***b* is removed.

In some embodiments the passageway **360** can provide a pathway for the power takeoff shaft **366** to extend up to or beyond an exterior surface **323***b* of the second chamber member **320**.

FIG. **9**E depicts a sectional view of the assembly shown in FIG. **9**D. FIG. **9**G depicts a detail view of FIG. **9**E. With reference to FIGS. **9**G and **9**E, the idler gear **310** is rotatably coupled with the idler gear shaft **312**. Optionally, the power takeoff shaft **366** extends from a faceplate **311** rigidly attached to the timing idler gear **310**. Optionally, the timing idler gear comprises a rim gear. Optionally, a second power takeoff shaft **366***a* can be coupled with the faceplate **311** and extend in a direction opposite the power takeoff shaft **366**. Optionally, when the power takeoff shaft **366***a* extends in the direction opposite the power takeoff shaft **366**, a second passageway **360***a* can be made in the first chamber member **321** and aligned with the second power takeoff shaft **366***a*.

The embodiments of FIGS. **9**E and **9**G and described above can be used with any of the different embodiments of the conversion kit or engine described herein.

In some embodiments of the conversion kit, the timing idler gear **310** is held substantially in place on the idler gear shaft **312** by an interior surface **323***a* of the second chamber member **320**. Optionally, a honed surface **322***a* can be included on the second chamber member **320** to reduce friction between idler gear **310** and the second chamber member **320**. Optionally, a honed surface **322** of the first chamber member **321** can be used to reduce friction between the idler gear **310** and the first chamber member **321**.

With continued reference to FIGS. **9**E and **9**G, the conversion kit can comprise a lubrication system for delivery a supply of oil to the rotating timing idler gear **310**. In some embodiments an oil supply line **383** is fluidly coupled with an oil reservoir **335***a* on one end and a lubrication space **334** on the other end and configured to deliver a supply of oil through the oil supply line **183**.

In some embodiments of the conversion kit, the kit comprises a self-contained lubrication system wherein the oil supply is recirculated independent of the lubrication system of the engine **300**. Optionally, the conversion kit comprises an oil pump **332** that pumps oil from within the chamber **335** through the oil supply line **383** and up to the lubrication space **334**. Optionally, the oil pump is located in the chamber **335**. Optionally, the oil pump is located exterior to the chamber **335**. Optionally, the oil supply line **383** is fluidly coupled with the oil reservoir **335***a* at the bottom of the chamber **335**. Optionally, the oil reservoir is located exterior to the chamber **335** or in another location within the chamber **335**. Optionally, the oil pump is configured to pump the oil supply through an interior portion **283***b* of the oil supply line **383**. Optionally, the interior portion comprises a passageway through either of the first or second chamber members **320**, **321**. Optionally, the interior portion **383***b* comprises the extension passageway **333** and/or passes through the boss **331**. Optionally, the oil supply line **383** can deliver a supply of oil to the lubrication space **334** directly through the idler shaft **312** without a boss.

In some other embodiments of the conversion kit, the lubrication system is coupled with the existing lubrication system of the engine **300**. Thus the conversion kit may comprise an oil supply line **383** fluidly coupled with an oil reservoir **380** (similar to oil reservoir **280**) and the lubrication space **334**. Optionally, the conversion kit also comprises a return line **382** fluidly coupled between the oil reservoir of the kit **335***a* at a drain **381** and the oil reservoir **380**.

FIG. **9**F depicts a partial sectional view of the assembly of FIG. **9**D showing one of the mechanical fasteners **352** and one of the interior mounting shafts **340**. Optionally, idler gear **310** is rotatably coupled to idler shaft **312** through bearing **315**. Optionally, the mechanical fastener **352** can be used to secure the second chamber member **320** to the interior mounting shaft **340** by threads **342**. Optionally, interior space **313** comprises an empty space, but in other embodiments comprises a solid volume. Optionally, the interior space **313** comprises the interior mounting shaft **340** and/or the threads **342**.

FIG. **10** depicts another embodiment of a power takeoff assembly which is compatible with each of the embodiments of the conversion kit and engines described herein. Optionally, the idler gear **410** is rotatably mounted to an idler shaft **412** with a faceplate **411** fixedly coupled with the idler gear **410**. Optionally, extending from the faceplate **411** is a power takeoff shaft **466**. Optionally, a power takeoff shaft **466** can comprise a beveled gear configured to mesh with a second beveled gear **433** and provide torque to an engine accessory **432**. Optionally, the power takeoff shaft **466** can extend through a passageway **460** through a chamber member **420**. Optionally, the engine accessory **432** can be fixedly mounted to the chamber member **420**. Optionally, the idler shaft **412** extends from one of the first or the second chamber members or from the engine housing wall.

FIG. **11** depicts another embodiment of an idler gear **510** comprising a first split section **510***a* and a second split section **510***b* rigidly connected with each other and rotating together on an idler shaft **512**. In some embodiments, an idler rim gear can define more than one idler gear, for example, by having multiple portions with different diameters each. For example, an idler rim gear can include two different diameters with gear teeth at each the two different diameters that rotate about the same idler shaft.

In other instances, one head of a multi-head engine (e.g. a V-type engine block) is offset from a second head of the engine, with two timing geartrains that are offset from each other (e.g., along the direction of the crankshaft of the engine) and correspond to the different heads. Optionally, the idler gear **510** comprises the first split section **510***a* having a first diameter and the second split section **510***b* having a second diameter. Optionally, the split section **510***a* can rotate about a first idler shaft section **512***a* having a corresponding first diameter and the split section **510***b* can rotate about a second idler shaft section **512***b* having a corresponding second diameter. Optionally, the first and second split sections can be rigidly attached by a faceplate **511**. Optionally, the idler shaft **512** extends from one of the chamber members or the engine housing wall. Optionally, corresponding split sections **512***a*, **512***b* extend from opposite chamber members and/or engine housing walls.

In some other embodiments, the first idler shaft section **512***a* and the second idler shaft section **512***b* meet at an interface **590**. Optionally, the interface **590** comprises two interlocking and concentric circular sections on each of the shaft sections **512***a, b*. Interface **590** can have the advantage of providing a haptic locating mechanism when aligning and mounting the chamber member or the engine housing wall with the corresponding engine housing wall or the chamber member.

In some embodiments the chamber member **510** can be coupled with the housing wall **502** through a mechanical fastener **552** extending from an exterior side of chamber member **510** through the engine housing wall **502**. Optionally, the mechanical fastener **552** can be a bolt and a nut **529**.

Each the embodiments of the disclosure shown in FIG. **11** and described in the preceding paragraphs can be used with each of the other embodiments described herein.

OEM Engines Using a Valvetrain and Comprising a Timing Idler Gear

FIGS. **12**A-**15**C depict an engine **600** that utilizes at least one idler shaft **612** and at least one corresponding timing idler gear **610**. Accordingly, each of the features of the above embodiments may be used in combination with the features of the engine **600**. FIG. **12**A depicts the engine **600** comprising the idler shaft **612** extending from an engine housing **602**. Optionally, the engine **600** comprises a head **603**, an engine block **601** and the engine housing **602**. Optionally, the engine **600** also comprises a crankshaft **607**, a crank gear **609**, a cam gear **605** and a camshaft **604**. Optionally, the idler shaft **612** is integrally formed with the engine housing **602**. In other embodiments the idler shaft **612** is mechanically fastened to the engine **600** through conventional means as described above in reference to previous embodiments.

FIG. **12**B depicts a sectional view of engine **600** taken in FIG. **12**A. Optionally, the engine **600** includes an interior space **613** and an exterior surface **612***a* of the idler shaft **612** configured to rotatably support the timing idler gear **610**. In some embodiments of the present invention, interior space **613** is an empty volume, but in other embodiments it is a solid volume. Optionally, engine **600** can also comprise an oil reservoir **680**. Optionally, the engine **600** can further comprise a plurality of mounting locations (not shown) configured to mount a chamber member **620** with the engine housing wall **602** (FIGS. **14**A, B).

In some embodiments, the idler gear **610** comprises a rim gear as shown herein and described above. Optionally, the idler gear **610** can comprise a power takeoff shaft with at least one passageway through the chamber member **620** as shown and described above in relation to the other embodiments.

FIGS. **13**A and **13**B depict an assembled view of the engine **600** comprising the timing idler gear **610** mounted on the idler shaft **612** and rotatably coupled with one of the crank gear **609** and/or the cam gear **605**. Optionally, timing idler gear **610** can be mounted onto the exterior surface **612***a* of the idler shaft **612**. Optionally, the timing idler gear **610** is mounted on a bearing **615**, such as a needle or ball bearing, that is mounted to the exterior surface **612***a* of the idler shaft **612** to reduce friction between idler shaft **612** and idler gear **610**. In other embodiments, the bearing **615** can be a plain, sleeve, or hydrodynamic bearing. Optionally, exterior surface **612***a* is honed to reduce friction between the idler gear **610** and the idler shaft **612**. In the form of plain or sleeve bearings, the bearing **615** can have a polished surface corresponding to the outer surface **612***a* of the idler shaft **612**, optionally lubricated with grease or oil. In some embodiments, oil for the bearing **615** is supplied continuously during operation so that the idler gear **610** rotates on a thin oil film, optionally, under the principle of operation of a hydrodynamic bearing.

FIGS. **14**A and **14**B depict a view of the engine **600** in an assembled state and including the chamber member **620**. In some embodiments, the chamber member **620** functions to maintain the idler gear **610** on the idler shaft **612** so that it can rotate securely about the idler shaft **612**. As described above in reference to other embodiments, both the engine housing wall **602** and the chamber member **620** can comprise honed portions to reduce friction at the locations where the timing idler gear **610** contacts the chamber member and the housing wall respectively.

In some embodiments of the engine **600**, chamber member **620** can comprise a peripheral wall **625** configured to create a chamber **635** that encompasses the idler gear **610**. Optionally, the wall **625** extends from the engine housing **602**. In a preferred embodiment, an interface between the peripheral wall **625** and the engine housing **602** comprises a gasket configured to seal the chamber **635** to prevent oil leakage. In another preferred embodiment, the chamber member **620** comprises a top portion and a bottom portion, the top portion being removable from the engine **600** with the lower portion remaining in place such that an oil reservoir **635***a* can retain an oil supply during partial disassembly of the engine **600**.

FIGS. **15**A-**15**C depict a view of engine **600** comprising a lubrication assembly. In some embodiments, an oil supply line **683** is fluidly coupled between an oil reservoir **680** and a lubrication space **634** located between the exterior surface **612***a* and the idler gear **610**. Optionally, the engine **600** comprises an oil pump (not shown) configured to deliver the oil supply from the reservoir **680** to the lubrication space **634**. Optionally, the oil supply line **683** comprises an interior portion that passes through the engine housing wall in a fluid passageway. Optionally, the oil supply line can comprise an exterior portion that passes through an oil tube. Optionally, a return oil line **682** can be coupled with the bottom of the chamber **635** and communicatively coupled to the oil reservoir **680** through a drain **681**. Optionally, the oil pump is located within the oil reservoir **680**. Optionally, the oil supply line **683** can fluidly couple the chamber **635** with the lubrication space **634**. Optionally, the oil pump is configured to deliver an oil supply to the lubrication space **634** from an oil reservoir **635***a* within the chamber **635**. Optionally, the oil pump is located within the chamber **635**. Optionally, the oil pump is located exterior to the chamber **635**.

In some embodiments, the chamber member **620** comprises a top portion **620***a* and a bottom portion **620***b*. Optionally, the bottom portion **620***b* is configured to comprise the oil reservoir **680** as discussed above. Optionally, both portions **620***a, b* are configured to be assembled with the engine **600**. Optionally, the bottom portion **620***b* is configured to remain assembled with the engine **600** when the top portion **620***a* is removed from the engine **600** and thereby the oil reservoir **680** can remain in place while an operator obtains access to the geartrain by removing the top portion **620***a*.

Although specific embodiments have been described above, these embodiments are not intended to limit the scope of the present disclosure, even where only a single embodiment is described with respect to a particular feature. Examples of features provided in the disclosure are intended to be illustrative rather than restrictive unless stated otherwise. The above description is intended to cover such alternatives, modifications, and equivalents as would be apparent to a person skilled in the art having the benefit of this disclosure.

The scope of the present disclosure includes any feature or combination of features disclosed herein (either explicitly or implicitly), or any generalization thereof, whether or not it mitigates any or all of the problems addressed herein. Accordingly, new claims may be formulated during prosecution of this application (or an application claiming priority thereto) to any such combination of features. In particular, with reference to the appended claims, features from dependent claims may be combined with those of the independent claims and features from respective independent claims may be combined in any appropriate manner and not merely in the specific combinations enumerated in the appended claims.

What is claimed is:

1. A valvetrain conversion kit for an engine, comprising:

at least one timing idler rim gear configured to be meshed with at least one of a crank gear of the engine and a cam gear of the engine;

a first timing gear chamber member having an interior surface and an exterior surface, the first timing gear chamber member having a plurality of engine mounting locations corresponding to a plurality of corresponding mounting locations on an internal combustion engine body, the first timing gear chamber member configured to be rigidly attached to an engine body at the plurality of engine mounting locations;

the first timing gear chamber member further comprising a timing idler rim gear shaft supported by the interior surface, the timing idler rim gear shaft having an exterior shaft surface, the exterior shaft surface configured for rotatably supporting the timing idler rim gear; and

an oil passage extending at least partially through an interior of the timing idler rim gear shaft to the exterior shaft surface and configured to guide an oil lubricant to a lubricant space between the exterior shaft surface and a rotational surface of the timing idler rim gear when the at least one timing idler rim gear is positioned about the exterior shaft surface.

2. The valvetrain conversion kit of claim **1**, further comprising: a second timing gear chamber member configured to engage the first timing gear chamber member to define an enclosed timing gear chamber about the at least one timing idler gear and the timing idler rim gear shaft.

3. The valvetrain conversion kit of claim **1**, further comprising:

a second timing idler rim gear;

a second timing idler gear shaft protruding from the interior cover surface of the timing gear chamber member; and

wherein the second idler rim gear is configured to be supported for rotation about the second timing idler gear shaft and meshed with at least one of the cam gear and the crank gear.

4. The valvetrain conversion kit of claim **1**, wherein the first timing gear chamber member comprises a monolithic material and the timing idler rim gear shaft and the first timing gear chamber member form a unitary structure.

5. The valvetrain conversion kit of claim **1**, wherein the first timing gear chamber member faces towards the engine when assembled with the internal combustion engine.

6. The valvetrain conversion kit of claim **1**, wherein the first timing gear chamber member faces away from the engine when assembled with the internal combustion engine.

7. An internal combustion engine comprising:

an engine body, the engine body supporting a crank shaft, an overhead valve camshaft, and a timing geartrain disposed on a first side of the engine body, the timing geartrain configured to transmit torque from the crankshaft to the overhead valve camshaft;

the timing geartrain including a crank gear coupled with the crankshaft, a cam gear coupled with the overhead valve camshaft, and an idler rim gear meshed with at least one of the crank gear and the cam gear;

an idler rim gear shaft disposed on the first side of the engine body and rotatably supporting the idler rim gear; and

an oil line, the oil line passing at least partially through an interior portion of the idler rim gear shaft and configured to guide an oil lubricant to a lubricant space between an exterior shaft surface and a rotational surface of the idler rim gear.

8. The internal combustion engine of claim **7**, further comprising a timing gear chamber member coupled with the engine body at a plurality of cover mounting locations to create a timing gear chamber, the timing gear chamber enclosing the idler rim gear shaft and the idler rim gear.

9. The internal combustion engine of claim **7**, wherein the idler rim gear is a webless gear.

10. The internal combustion engine of claim **8**, the idler rim gear comprising an outside diameter and an inside diameter, wherein the inside diameter is equal to or greater than approximately 50% of the outside diameter.

11. An internal combustion engine comprising:

an engine body, the engine body supporting a crank shaft, an overhead valve camshaft, and a timing geartrain disposed on a first side of the engine body, the timing geartrain configured to transmit torque from the crankshaft to the overhead valve camshaft;

the timing geartrain including a crank gear coupled with the crankshaft, a cam gear coupled with the overhead valve camshaft, and an idler rim gear meshed with at least one of the crank gear and the cam gear;

a timing gear chamber member coupled with the engine body at a plurality of cover mounting locations to create a timing gear chamber, the timing gear chamber enclosing the idler rim gear shaft and the idler rim gear;

an idler rim gear shaft disposed on the first side of the engine body and rotatably supporting the idler rim gear, the idler rim gear comprising a power take-off shaft configured to extend out of the timing gear chamber.

12. A valvetrain conversion kit for an engine, comprising: at least one timing idler gear; and

a first timing gear chamber member having a plurality of engine body mounting locations and a timing idler gear shaft configured for rotatably supporting the timing idler gear; and

an oil passage extending at least partially through an interior of the timing idler gear shaft to an exterior shaft surface and configured to guide an oil lubricant to a lubricant space between the exterior shaft surface and the at least one timing idler gear when assembled together.

13. The valvetrain conversion kit for an engine of claim **12**, wherein the at least one timing idler gear is configured to be meshed with at least one of a crank gear of the engine and a cam gear of the engine.

14. The valvetrain conversion kit for an engine of claim **12**, wherein the first timing gear chamber member is configured to be rigidly attached to an engine body at the plurality of engine mounting locations.

15. The valvetrain conversion kit of claim **12**, wherein the timing idler gear is a rim gear.

16. The valvetrain conversion kit of claim **15**, the rim gear comprising an outside diameter and an inside diameter, wherein the inside diameter is equal to or greater than approximately 50% of the outside diameter.

17. The valvetrain conversion kit of claim **15**, the rim gear comprising an outside diameter and an inside diameter, wherein the inside diameter is equal to or greater than approximately 75% of the outside diameter.

18. The valvetrain conversion kit of claim **12** wherein the timing idler gear is configured to be rotatably supported by the timing idler gear shaft without a bearing.

19. A valvetrain conversion kit for an engine, comprising: at least one timing idler gear; and

a first timing gear chamber member having a plurality of engine body mounting locations and a timing idler gear shaft configured for rotatably supporting the timing idler gear, the timing idler gear comprising a power take-off shaft.

20. The valvetrain conversion kit of claim **19**, the power take-off shaft rigidly coupled with the timing idler gear through a face plate.

21. A valvetrain conversion kit for an engine, comprising: at least one timing idler gear;

a first timing gear chamber member having a plurality of engine body mounting locations and a timing idler gear shaft configured for rotatably supporting the timing idler gear; and

a second timing gear chamber member having a plurality of cover mounting locations, the second timing gear chamber member being configured to create a chamber to enclose the at least one timing idler gear, a crank gear, and a cam gear when assembled with the first timing gear chamber member;

wherein the second timing gear chamber member comprises a top portion and a bottom portion, the bottom portion configured to remain assembled with the first timing gear chamber member when the top portion is removed from the first timing gear chamber member.

22. The valvetrain conversion kit of claim **21**, wherein the bottom portion of the second timing gear chamber member is configured to comprise an oil reservoir when assembled with the first timing gear chamber member.

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